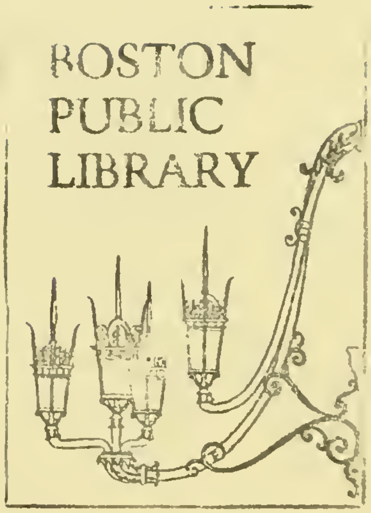

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LONGWOOD MEDICAL AREA TRANSPORTATION STUDY

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Recommended Improvements

May, 1988

LONGWOOD MEDICAL AREA TRANSPORTATION STUDY

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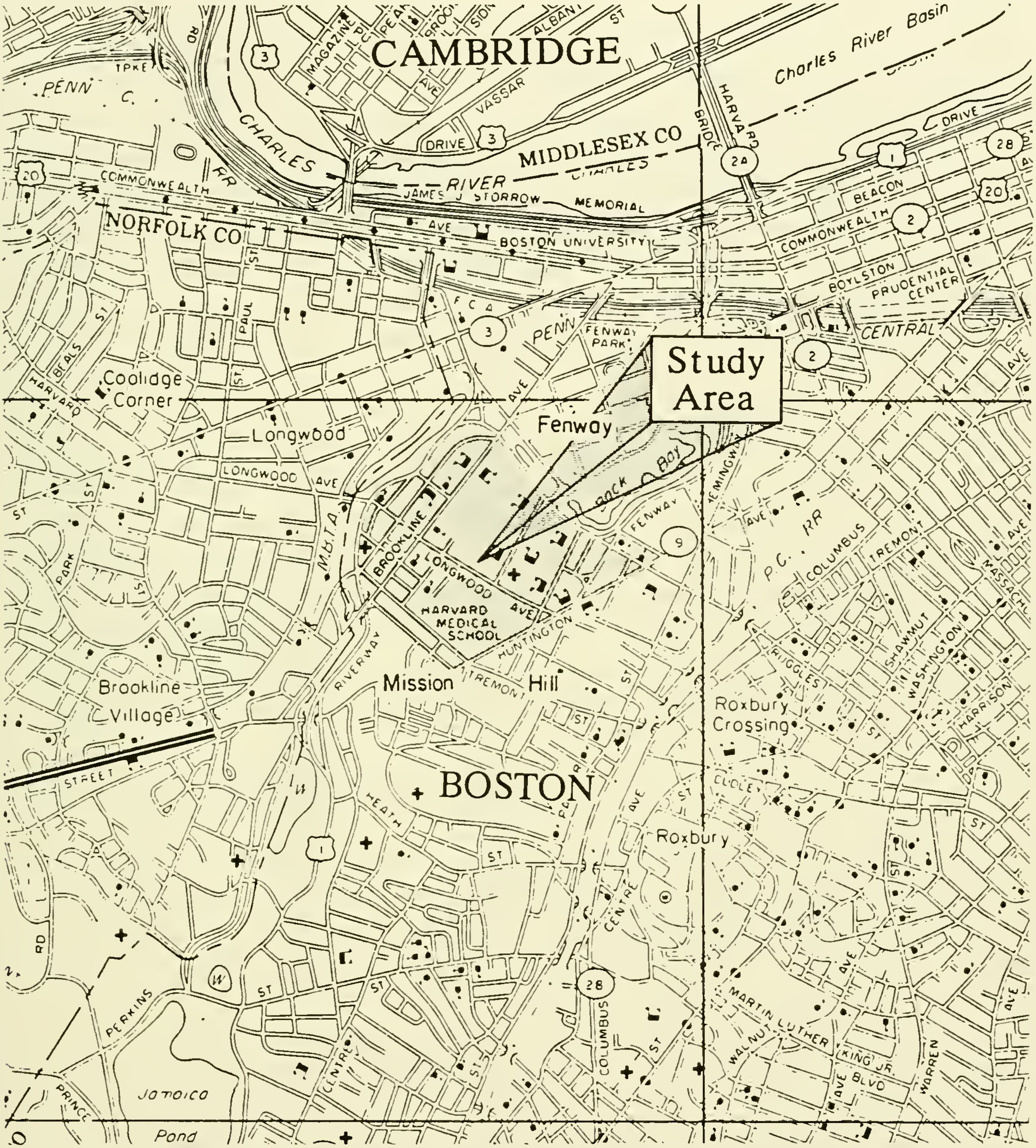
Introduction

I. INTRODUCTION

A. THE LONGWOOD MEDICAL AREA

The Longwood Medical Area (LMA) is a 175-acre site located adjacent to the Fenway and Mission Hill neighborhoods of Boston (see Figure 1). Its high concentration of institutions has grown over an eighty-year period to be one of the most prestigious centers of medical and educational service in the region and the country. The Medical Area Service Corporation (MASCO) is a shared service organization in the Longwood Medical Area. Created in 1972 by medical and educational institutions, MASCO assists its members as well as other non-profit institutions in carrying out their functions effectively and efficiently. MASCO's goals are: to reduce costs by utilizing substantial economies of scale; to provide employee and student support services; and to create a sense of community through area-wide planning and development efforts.

MASCO's 15 member institutions include four major teaching hospitals (Beth Israel, Brigham & Women's, Children's, and New England Deaconess), two important research treatment centers (Dana-Farber Cancer Institute and Joslin Diabetes Center), the Harvard Medical School, Harvard School of Dental Medicine, and Harvard School of Public Health, four other historic colleges (Emmanuel, Simmons, Wheelock, and Massachusetts College of Pharmacy and Allied Health Sciences), a girls' preparatory school (The Winsor School), and Temple Israel. Non-member institutions located in the LMA include the state-owned Massachusetts College of Art and Massachusetts Mental Health Center, the city-owned Boston Latin High School and Boston English High School, and the private non-profit Judge Baker Children's Center.



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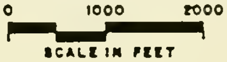


Study Area Location Map

Fig. 1

In total, these 20 institutions coexist with other land uses in an intensely urbanized area bounded by the Riverway, Fenway, and Huntington Avenue (see Figure 2). Adjacent to the LMA are the Town of Brookline and two Boston neighborhoods: the Fenway and Mission Hill. Also located nearby are other important Boston institutions, including the Museum of Fine Arts, Boston University, Wentworth Institute of Technology, and Northeastern University, to name a few. Downtown Boston lies just two miles to the northeast.

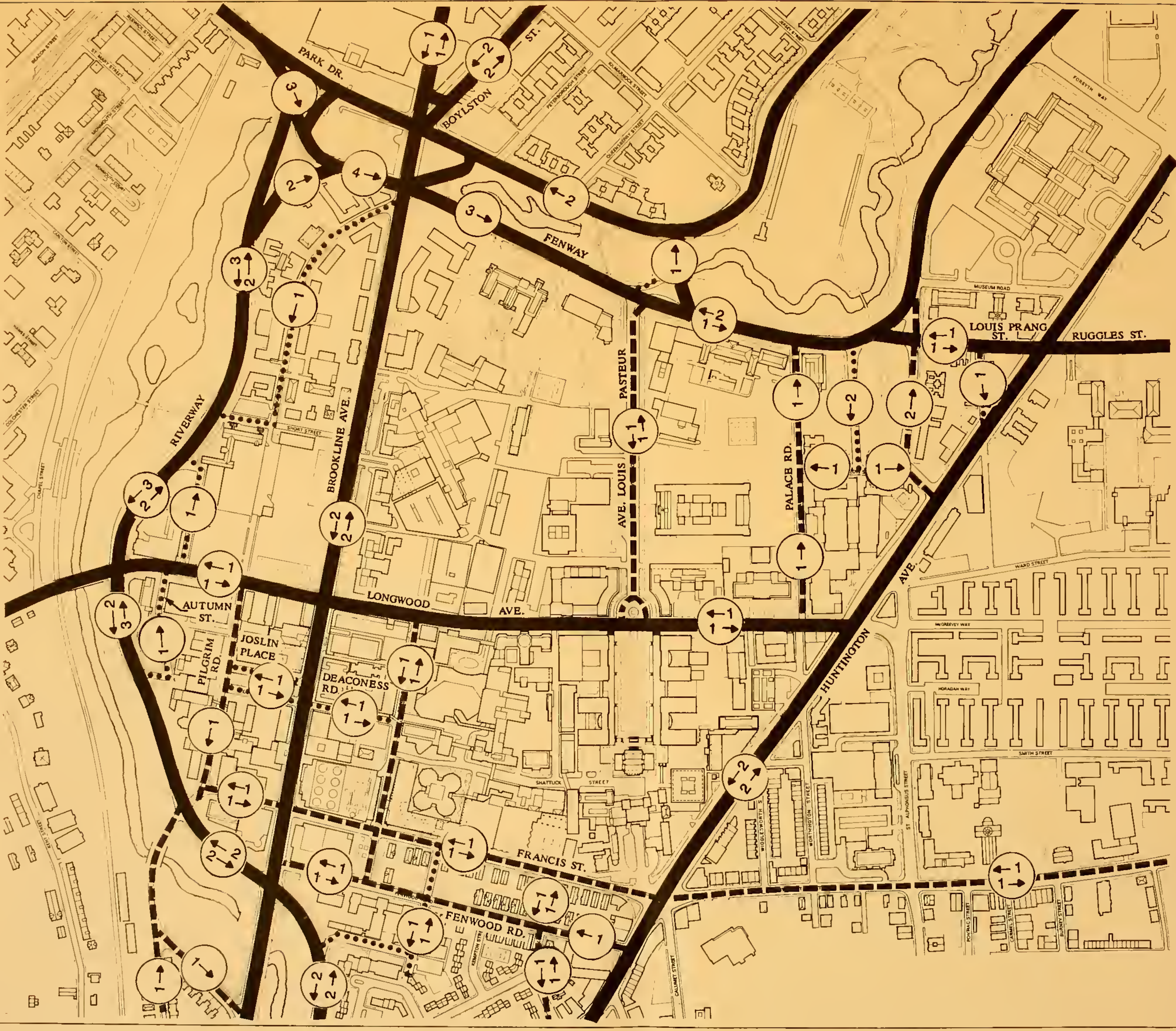
The LMA is traversed by several commuting routes to downtown Boston. As an activity center, downtown Boston continues to thrive, and the rate of new development is increasing. The combination of LMA land uses, its proximity to surrounding areas, and its location along major downtown commuting routes presents challenging transportation problems. Adding to this challenge is the need for additional development among the member institutions themselves in order to accommodate their own program needs.

B. THE LMA TRANSPORTATION STUDY

The LMA Transportation Study was initiated one year ago by Vanasse Hangen Brustlin, Inc. (VHB) under contract to the Medical Area Service Corporation (MASCO). A comprehensive approach was taken, addressing the following study goals:

- Thoroughly evaluate the existing transportation conditions in the LMA;
- Develop a five-year growth projection and assess its impact on the LMA's transportation system; and
- Evaluate alternative transportation improvement options, both short-term and long-term.

Existing Traffic Circulation Pattern & Functional Roadway Classification



LEGEND:

▬ ARTERIALS (Through Movement & Some Land Access)

‒ ‒ ‒ COLLECTOR (Through Movement & Land Access)

•••••• LOCAL (Land Access)

⇄ Number of Travel Lanes by Direction

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Fig. 2

During the course of the study, MASCO and VHB worked together to produce updated data and analyses. This information now provides a detailed picture of transportation for the LMA as an important sub-area within the City of Boston. Furthermore, the study has addressed directly more than 50 improvement options to reduce traffic congestion in the area, outlining a recommended plan.

Each of the three study goals was addressed in a distinctive phase addressing specific objectives. A report was produced for each phase, and this report represents the third and final product of the effort, containing an analysis of alternative improvements and presenting a recommended plan of action.

Phase I of the study involved extensive data collection efforts supplementing information available from recent studies in the area. Traffic counts, roadway user surveys, physical inventories, and surveys of the institutions were conducted during the first several months. Meetings were held between the study team and the Boston Transportation Department and the Boston Redevelopment Authority to gather the City's input. A meeting with the Institutional Transportation Planning Advisory Committee (ITPAC) was also held to obtain input from representatives of surrounding neighborhoods.

In August, 1987, after months of data collection, verification, and analyses, a draft of Technical Memorandum #1 - Summary of Existing Conditions was distributed to MASCO and subsequently to each of its 14 member institutions. The report outlines existing land uses, defines the transportation system, describes patterns of area travel, and measures quantitatively and qualitatively the effectiveness of the transportation system in meeting the needs of the area. A presentation was made by VHB to the

member institutions, summarizing the findings. Generally, the report was well received and a final version was published in November, 1987, and distributed to the City of Boston and the member institutions.

Phase II of the study involved the development of growth assumptions for a five-year time frame and the quantification of traffic projections. Technical Memorandum #2 - Five Year Growth Horizon, published in April, 1988, concisely documents the impacts of likely additional development and compares the results with the existing conditions.

The final efforts during Phase III have concentrated on consideration of more than 50 alternative options for improving the overall level of transportation service in the LMA, including roadway improvements, traffic reduction measures, transit improvements, and pedestrian access improvements. The focus has been on options which can be implemented within the five-year time frame in order to meet the forecast transportation demand. A final set of recommendations is made for the short-term and for the five-year horizon, defining the roles needed by MASCO, the LMA institutions and various public agencies.

Analysis of Alternatives

II. ANALYSIS OF ALTERNATIVES

This chapter presents the analysis results for all the improvement strategies evaluated. For each strategy, the most important advantages and disadvantages are identified. Specific recommendations are discussed in Chapter III.

In Chapter II, the first section covers all strategies requiring any construction, however minor, while the second section deals with roadway improvements that require no construction. Circulation changes are covered in the third section because they have system-wide impacts and require complex analysis.

The next three sections depart from traditional traffic engineering strategies. The section on traffic reduction analyzes a wide variety of techniques designed to reduce the number of daily or peak hour vehicle trips on LMA roadways. The next section deals with a closely related subject, management strategies, which include such diverse elements as parking management techniques and development impact fees. The next section covers improvements to the pedestrian environment in the LMA. The final section covers site design.

A. ROADWAY CONSTRUCTION STRATEGIES

The eight roadway construction strategies evaluated are listed below:

A1. Modify the Intersection of Fenway and Avenue Louis Pasteur.
A2. Connect Parking Facilities to Avenue Louis Pasteur.
A3. Widen Longwood Avenue between Binney Street and Brookline Avenue.

A4. Widen Longwood Avenue between the Riverway and Chapel Street.

A5. Reconstruct the intersection of Huntington and Longwood Avenues.

A6. Widen Louis Prang Street.

A7. Extend Tetlow Street to Avenue Louis Pasteur.

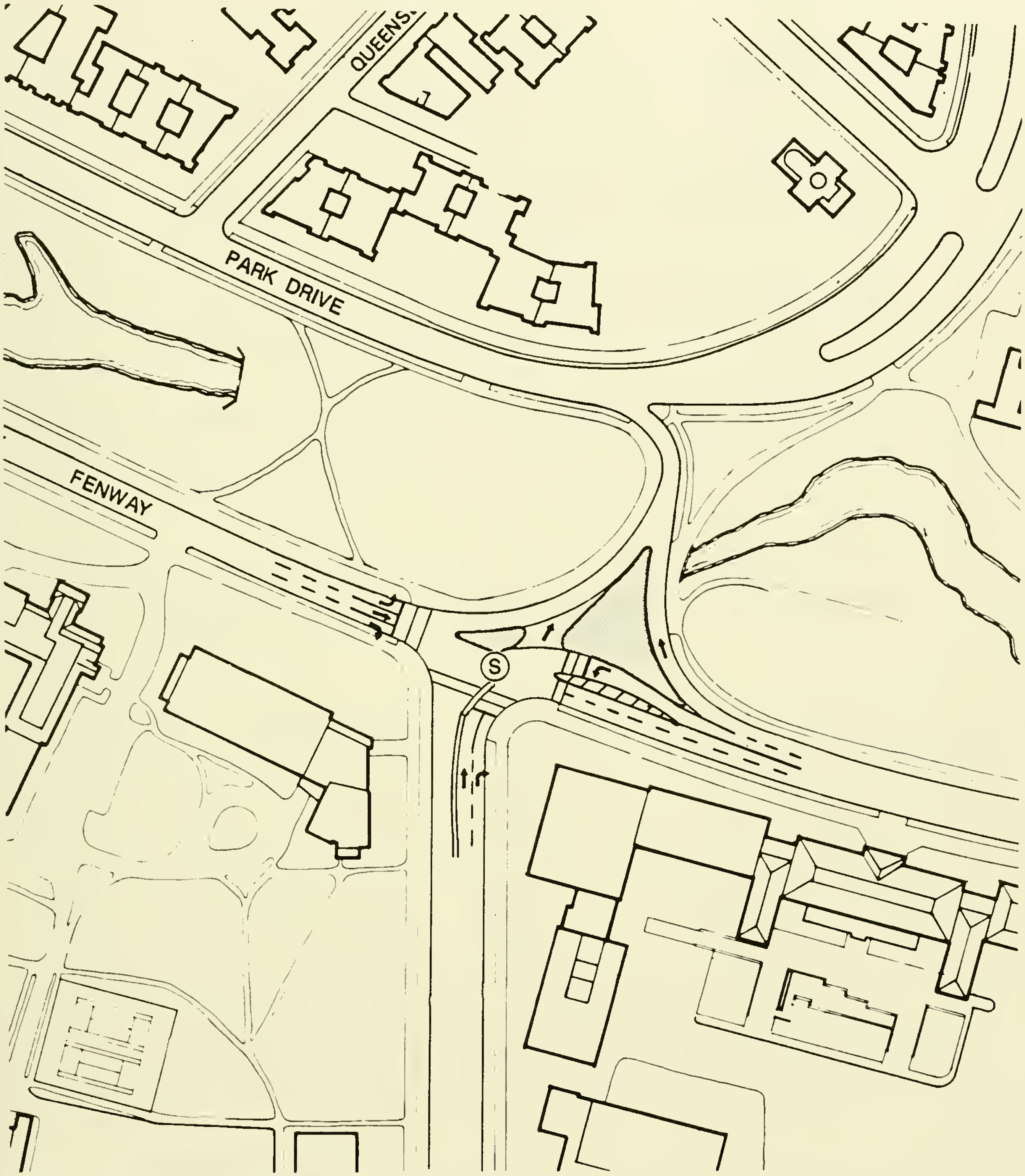
A8. Modify the Sears Rotary.

The first two strategies would increase utilization of Avenue Louis Pasteur, thereby relieving congestion on Brookline Avenue. The next three would increase the capacity of Longwood Avenue. The next two options deal with east-west travel in the northeast corner of the LMA. The final strategy is a set of alternative improvements to the Sears Rotary, where Brookline Avenue, Riverway, Park drive, Fenway and Boylston Street all converge.

A1. Modify the Intersection of Fenway and Avenue Louis Pasteur

Currently, most vehicles traveling from Avenue Louis Pasteur to Park Drive must pass through the congested Longwood Avenue/ Brookline Avenue intersection. Some drivers avoid the congestion by making an unsafe and illegal U-turn on the Fenway just east of Avenue Louis Pasteur. This proposal, a variant of the one suggested in the 1975 transportation study commissioned by MASCO, would allow traffic to proceed directly from Avenue Louis Pasteur to Park Drive westbound. As shown in Figure 3, the proposal would require minor geometric modifications at the intersection as well as a signal to assure that the new traffic movement could be accommodated safely.

Implementation of this proposal would have the following benefits:



Fenway/ Ave. Louis Pasteur Intersection Modification

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Fig. 3

- It would eliminate the excess travel time required by the existing turn restriction.

- It would relieve congestion at the Longwood Avenue/ Brookline Avenue intersection.

- It would improve traffic safety at the Fenway/Avenue Louis Pasteur intersection.

- It would improve safety for pedestrians crossing the Fenway in the existing crosswalk on the west side of the intersection.

- A signal at this location is warranted under Signal Warrant #1 of the Manual on Uniform Traffic Control Devices.[1]

Through traffic on the Fenway would be somewhat inconvenienced because installation of a signal generally increases delay on the major street. Delays could be minimized through the use of an actuated signal, which would give Fenway traffic a green light except when a change was actuated by a vehicle on Avenue Louis Pasteur or by a pedestrian. The incidence of actuation, and thus the delay to through traffic, could be reduced by providing an exclusive right-turn lane on the Avenue Louis Pasteur approach, posting a sign to remind drivers on that approach that right turns on red are permitted, and installing the detection loop only under the through lane. Delays to

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1/ Federal Highway Administration, Manual on Uniform Traffic Control Devices, Revised 1983.

through traffic could be further reduced through coordination with the existing signal at the Fenway/Brookline Avenue intersection. (Other alternatives include building a delay into the vehicle detection loop to reduce delay on the major street.)

A2. Connect Parking Facilities to Avenue Louis Pasteur

The idea of connecting Avenue Louis Pasteur to some of the area's major parking resources, particularly those at the Beth Israel Hospital and at Children's Hospital, has received considerable attention in the past. Although it was recommended in the 1975 transportation study commissioned by MASCO,[2] it has not been implemented to date. As shown in Figure 4, such a connection would provide a "relief valve" for traffic by removing it from the more congested Brookline and Longwood Avenues to the less traveled Avenue Louis Pasteur.

It appears that the main stumbling block to implementation of the connector is obtaining the necessary right-of-way. Three alignments are possible: (1) the existing driveway that runs adjacent to Emmanuel College's Alumnae Hall, (2) a parking lot adjacent to Boston English High School, and (3) a more southerly passageway between the high school and Harvard's Vanderbilt Hall. If the second option were chosen, the existing parking spaces in the high school lot would have to be replaced, most likely in the parking lots behind the school. Regardless of the option selected, there would be potential parking management concerns

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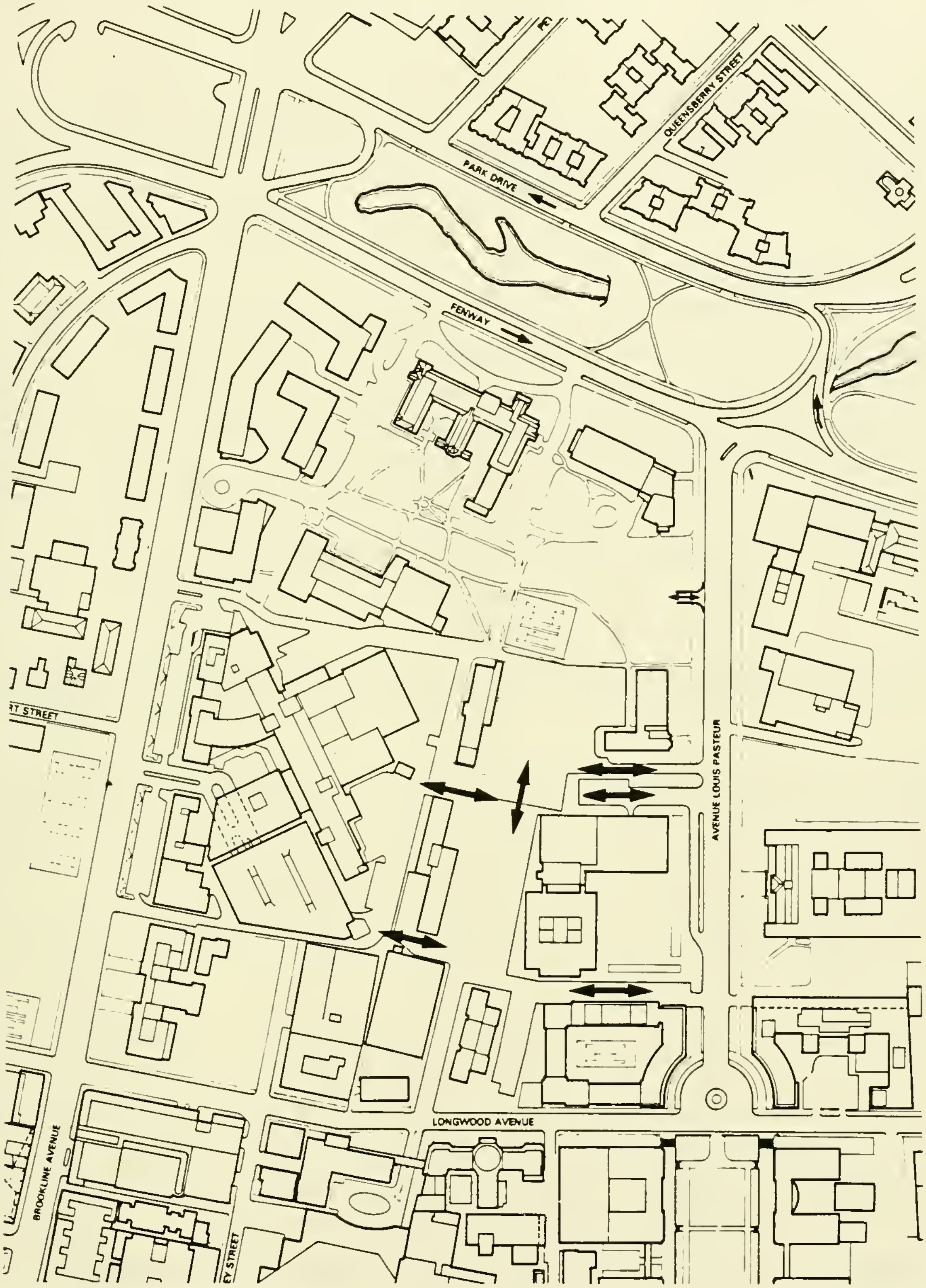
2/ Charles G. Hilgenhurst & Associates and Wilbur Smith & Associates, "Transportation Planning For The Longwood Medical Area," 1975.



Parking Connectors

LEGEND:

⟷ Potential New Connectors to Major Parking Areas

⟷ Potential New Curb Cut for Emmanuel College Faculty/Staff Parking Lots

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Fig. 4

regarding the mixing of parkers from different facilities. Also, a control plan would be needed to prevent through traffic from using the connector, which is intended for authorized parkers and not as a public street.

In addition, a new curb cut on the northern section of Avenue Louis Pasteur could serve the Emmanuel College faculty and staff parking lots, one of which already has frontage (but no driveway) on the avenue. These five interconnected parking areas, with a combined capacity of 250 vehicles, are currently accessible only from the Fenway, which is one-way eastbound. The proposed curb cut would improve access for parking lot users and reduce traffic volume at the Brookline Avenue/Fenway intersection.

A3. Widen Longwood Avenue Between Binney Street and Brookline Avenue

It has been proposed, in conjunction with development on the Massachusetts College of Art (MCA) site on the northeast corner of Brookline and Longwood Avenues, that a portion of that site be used to widen Longwood Avenue. This would allow the number of westbound approach lanes to be increased from two to three.

Development of the MCA site was not assumed to be completed in the five-year time frame for which traffic volumes were forecast. Assuming the traffic volumes forecast in the five-year time frame and no other improvements at the Longwood Avenue/ Brookline Avenue intersection, the proposed widening would improve level of service on the westbound approach from "F" to "D" in the PM peak hour. While the intersection as a whole would still perform at Level-of-Service "F", the proposal has several other advantages:

- It would provide more room to store the queue on the westbound approach, so that the queue would extend back across Binney Street less frequently.

- It would make it easier for trucks and buses to turn right on Brookline Avenue. Approximately 15 buses make this turn during the AM peak hour currently.

- It would have greater benefits for the intersection as a whole when the MCA site is developed.

- It could be financed through development of the MCA site.

A4. Widen Longwood Avenue Between the Riverway and Chapel Street

Widening this section of Longwood Avenue was proposed as a means of improving level of service at the Riverway/Longwood Avenue intersection. Investigation revealed that the proposal is infeasible. The entire section is on a bridge designed by Frederick Law Olmsted and listed in the National Register of Historic Places. Any widening would adversely affect the appearance of the bridge and would therefore not be approved. Other proposals to improve level of service at the Riverway/Longwood Avenue intersection are evaluated elsewhere in this report.

A5. Reconstruct the Intersection of Huntington and Longwood Avenues

It was suggested that geometric changes including widening might be appropriate at the Huntington Avenue/Longwood Avenue intersection. Analysis of this intersection concluded that such reconstruction was not necessary because less expensive alterna-

tives are available. A northbound left-turn prohibition at this location is discussed in Section C, "Circulation Changes," and reallocation of the existing pavement width is discussed in Section B, "Other Roadway Improvements."

A6. Widen Louis Prang Street

Louis Prang Street serves an important crosstown function by connecting Ruggles Street with the Fenway and Park Drive. On its most critical segment (Vancouver Street to Huntington Avenue), Louis Prang Street is 31 feet wide with one 9-foot eastbound travel lane and one 22-foot westbound lane used for both travel and parking. Existing traffic congestion on this street is evidenced by Level-of-Service "F" in the PM peak hour on the eastbound approach to the Louis Prang Street/Huntington Avenue/ Ruggles Street intersection.

Analysis of a proposal to widen this street concluded that existing and forecast traffic volumes can be accommodated by the existing 31-foot width if the available width and the available green signal time at the Huntington Avenue intersection are optimally allocated as described in the Other Roadway Improvements section of this report. For westbound traffic, a single travel lane is adequate for the peak hour volumes, both existing (645) and forecast (850), because there is no signal to delay westbound traffic on Louis Prang Street. A single travel lane is adequate also for eastbound peak hour volumes, both existing (515) and forecast (580). Moreover, since over 90 percent of eastbound traffic travels straight across Huntington Avenue into Ruggles Street's single eastbound lane, provision of two eastbound lanes on Louis Prang Street would have limited value.

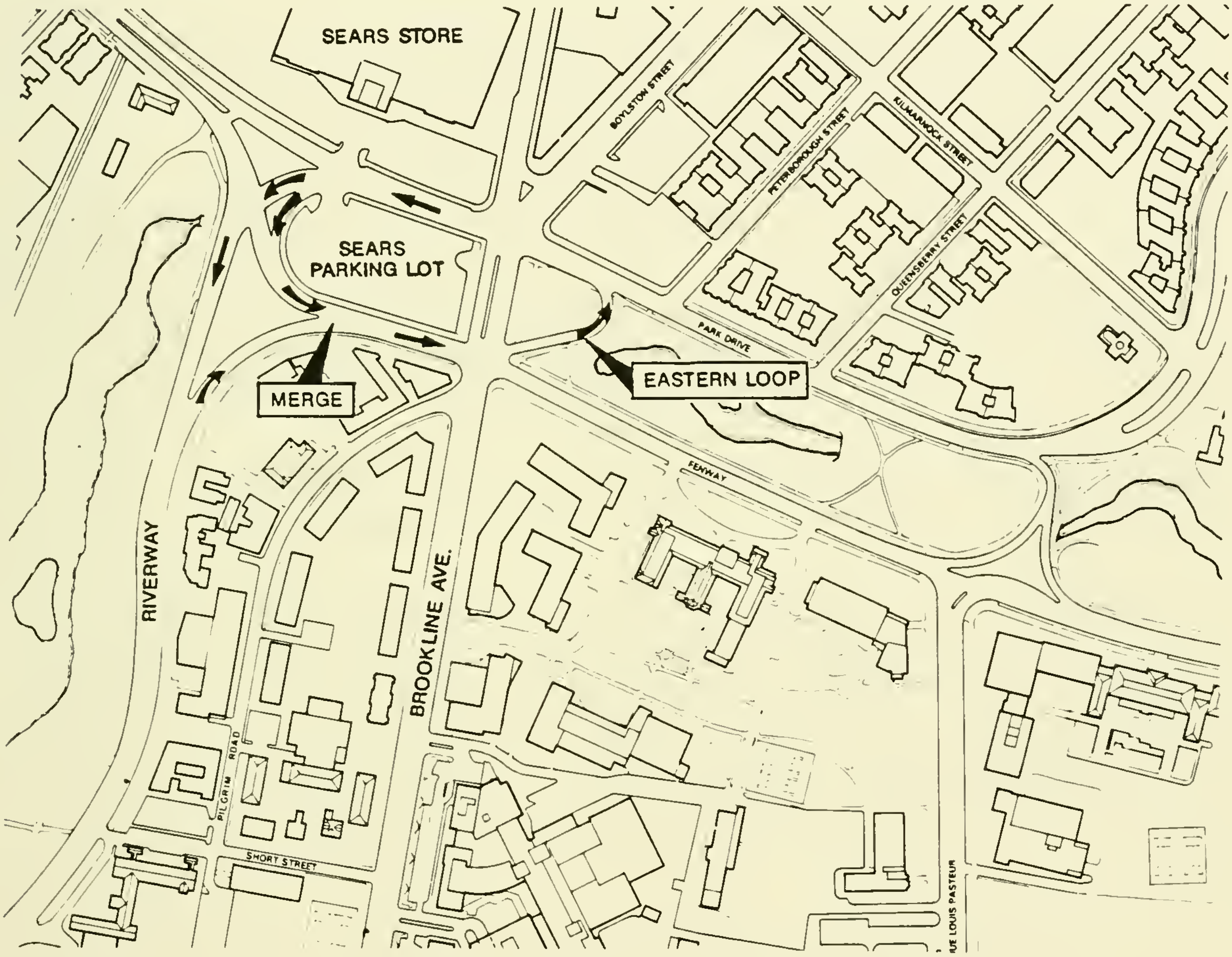
A7. Extend Tetlow Street to Avenue Louis Pasteur

Extension of Tetlow Street from Palace Road to Avenue Louis Pasteur through the Boston Latin School property was suggested in conjunction with Item #A2 (Connect Garages to Avenue Louis Pasteur) in order to provide another link between Huntington Avenue and major LMA parking facilities. Such a link might ease congestion at Huntington Avenue's intersections with Longwood Avenue and Louis Prang Street. However, the proposal would be expensive and would significantly impact the Latin School. Moreover, the proposal would require abandonment of the one-way designations currently employed on Tetlow Street to preclude its use by through traffic (see Figure 2 in Chapter I).

A8. Modify the Sears Rotary

The junction of Brookline Avenue, Boylston Street, Park Drive, the Fenway and the Riverway functions as a complex rotary (see Figure 5). Brookline Avenue cuts straight through the rotary, and signals control all conflicting traffic movements except the merge of northbound Riverway with eastbound rotary traffic. The interior of the rotary west of Brookline Avenue is currently used a parking lot built to serve the recently closed Sears store. The proposed restoration of the parking lot to its former green space use offers an opportunity to construct roadway improvements which are compatible with the City of Boston's open space objectives. Several specific proposals have been suggested and are evaluated in this section:

1. Construct a tunnel to carry Brookline Avenue under the rotary rather than through it, potentially improving traffic flow as well as the pedestrian/parkland environment.



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Existing
Sears Rotary

Fig. 5

2. Remove the little-used eastern loop of the rotary, potentially improving traffic flow as well as the pedestrian/parkland environment.

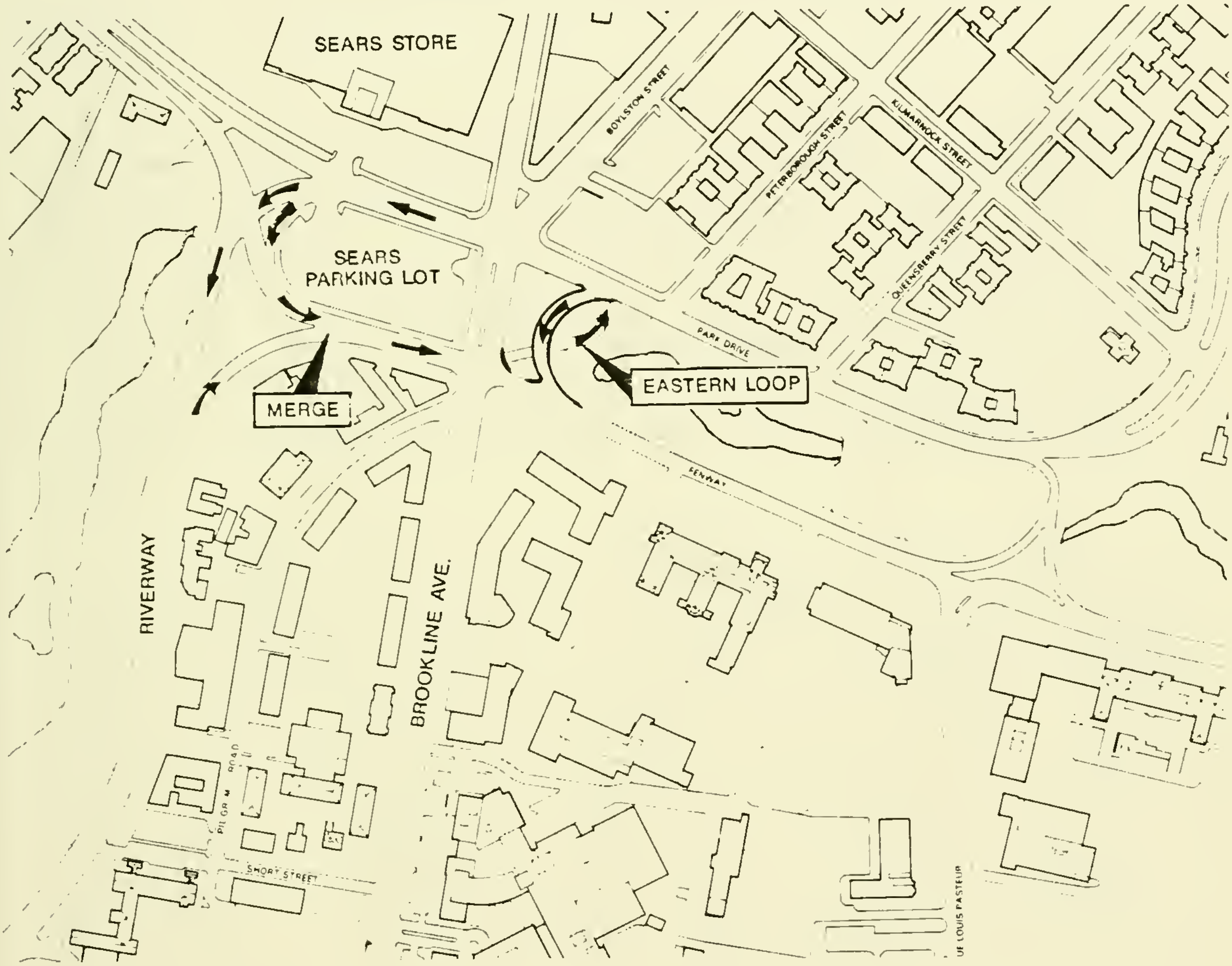
3. Reconstruct the eastern loop of the rotary as shown in Figure 6, so that it carries traffic from Park Drive to Fenway instead of from Fenway to Park Drive, potentially improving traffic flow without any effect on the pedestrian/parkland environment.

4. Close the southbound lanes of Brookline Avenue through the rotary, potentially improving traffic flow as well as the pedestrian/parkland environment.

5. Signalize the merge of northbound Riverway with eastbound rotary traffic.

The tunnel proposal is virtually infeasible. It would be extremely costly and would impact privately owned parcels and perhaps buildings. During the construction period, traffic diversions would exacerbate delays throughout the area. Moreover, due to the high percentage of turning movements, grade separation would not have enormous traffic flow benefits.

The second and third proposals, either of which would simplify the rotary by discontinuing its eastern loop, would reduce traffic delays and eliminate a confusing and unsafe condition on the eastbound approach to the Brookline Avenue/Fenway signal. Currently, traffic on this four lane approach has four choices including two kinds of left turns. During peak hours, the volume turning sharp left on Brookline Avenue is too high to be served by the left lane alone, so these drivers use the left two lanes. An unsafe situation occurs when a driver in the far



Sears Rotary Eastern Loop Reversal

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Fig. 6

left lane bears left onto the eastern loop of the rotary while a driver in the second lane tries to make a sharp left onto Brookline Avenue. The resulting confusion also causes delays in excess of those estimated by computerized level of service analysis techniques.

One of the circulation changes analyzed in this chapter, the Riverway-Brookline Avenue one-way pair, would solve the problem by reducing the peak hour left-turn volume to a number that could easily be accommodated in the far left lane. If the one-way pair were in effect, the rotary's eastern loop would not need to be eliminated. In fact, its utilization level and importance to the roadway system would be increased. However, with the current circulation system, the loop interferes with traffic flow and safety.

The primary drawback of eliminating the loop relates to trucks and buses. For passenger cars now using the loop, another existing loop just 1000 feet to the east is an acceptable alternative, but heavy vehicles are barred from that route by Metropolitan District Commission (MDC) regulations. Attempting to close the loop to passenger cars while admitting trucks and buses might just add to the confusion and create enforcement difficulties. Since virtually all vehicles using the loop are destined for Park Drive westbound, another possibility would be to exempt heavy vehicles from the northbound left turn restriction at Brookline Avenue and Park Drive. However, this scheme would impede enforcement of the left turn regulation, which already is violated by approximately 45 drivers during each peak hour. Because fewer than 10 heavy vehicles per hour currently use the eastern loop, the MDC might be persuaded to allow these vehicles to use the alternate route suggested for passenger cars.

The third proposal would eliminate the loop as it exists today, but reconstruct it as a loop from Park Drive westbound to Fenway eastbound. The advantage of this proposal is that it would encourage LMA-bound drivers to travel via the underutilized Avenue Louis Pasteur rather than via the more congested Brookline Avenue.

The chief disadvantage of reversing the loop rather than just discontinuing it is that some traffic which now approaches the LMA on Boylston Street, which is mainly commercial, would probably shift to Park Drive, a predominantly residential street. Another disadvantage of the third proposal, compared with the second, is that simply discontinuing the loop would allow it to be reopened later if the Riverway-Brookline Avenue one-way pair were implemented.

The fourth proposal, closing the southbound lanes of Brookline Avenue between Park Drive and the Fenway, is intended to relieve traffic congestion on Brookline Avenue throughout the LMA by encouraging drivers to use the Riverway and Avenue Louis Pasteur. The present circulation system encourages use of Brookline Avenue by providing a shortcut through the rotary for Brookline Avenue traffic only. Eliminating that shortcut might result in a better allocation of traffic to available roadways.

The lane closure proposal was not analyzed in detail because a preliminary review suggested that it would not result in a net improvement for the system as a whole. (This proposal could be reanalyzed when more is known about potential development at the Sears site.) Because some Brookline Avenue traffic would shift to the Riverway, the Riverway/Longwood Avenue intersection would be adversely affected to some degree. Traffic flow would improve at all Brookline Avenue intersections south of the rotary, up to and including the Riverway/Brookline Avenue intersection.

The final Sears rotary proposal, signalization of the Riverway merge, is feasible and would have significant benefits for traffic flow and safety. Coordination with the existing signals would prevent traffic queues from one intersection from blocking adjacent intersections.

B. OTHER ROADWAY IMPROVEMENTS

This section presents analysis of various roadway improvement strategies that do not require any construction work. Circulation changes are treated separately in the following section.

Ten strategies are evaluated in this section:

B1. Remove parking on Brookline Avenue between Longwood Avenue and the Riverway.
B2. Remove parking on Brookline Avenue between Longwood Avenue and Fenway.
B3. Remove parking on Brookline Avenue south of the Riverway.
B4. Remove parking on Longwood Avenue between Brookline and Huntington Avenues.
B5. Remove parking on Longwood Avenue between Brookline Avenue and the Riverway.
B6. Remove parking on Francis Street between Brookline and Huntington Avenues.
B7. Restripe Longwood Avenue as three lanes between Brookline and Huntington Avenues.
B8. Miscellaneous restriping of pavements.
B9. Enhance the effectiveness of the Longwood Avenue/Riverway signal.
B10. Reopen Worthington Street.

Of these ten strategies, the first eight are so closely related that they are evaluated as a group. All ten are presented graphically in Figure 7.

B1-B8. Reallocate Existing Pavement Width

The most promising measures in this category are the removal of all daytime curbside parking from Brookline and Longwood Avenues and certain Huntington Avenue intersection approaches. In general, on-street parking reduces the number of lanes available for moving traffic, and also impedes flow in the remaining travel lanes when vehicles maneuver into and out of parking spaces. Nationally, about 17 percent of all urban accidents are known to involve parking or parked vehicles along streets.[3] At signalized intersections, where traffic can move only during a limited period of time (the green phase), delays are usually greatly reduced when the number of available travel lanes is increased. Curbside parking interferes with turning trucks and buses, and poses safety problems by obstructing drivers' view of pedestrians attempting to cross the street. In the Longwood Medical Area, the traffic flow impacts of on-street parking make in more difficult for emergency vehicles to access the medical facilities. Thus the removal of on-street parking on Brookline and Longwood Avenues and at selected Huntington Avenue locations has the potential to reduce delay substantially at key signalized intersections as well as improving overall traffic flow and safety.

Removal of on-street parking, especially short-term metered parking, can have an adverse impact on retail activity. However, the clientele of LMA retail establishments is largely comprised of institutional employees, students and visitors, who walk from

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3/ Transportation Research Board, Parking Principles, TRB Special Report #125, 1971.

Other Roadway Improvements Evaluated

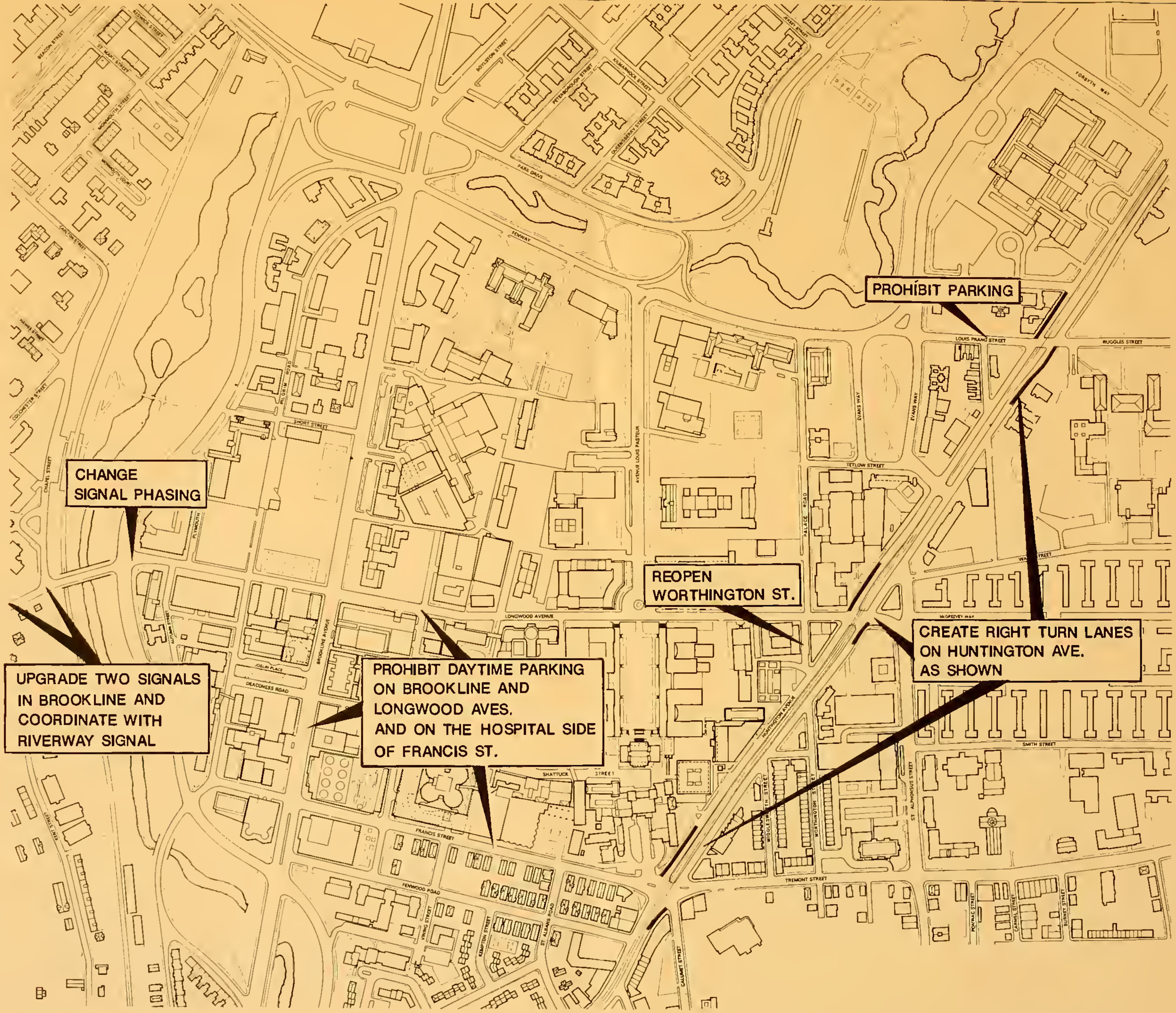

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Fig. 7

the institutions to the area businesses. In 1985, only nine (2.5 percent) of the 358 shoppers interviewed at retail establishments in the LMA had driven to the LMA for the purpose of shopping. Thus, it can be concluded that the LMA is a special case in which retail establishments are not highly dependent on the existing on-street parking supply.

While most metered spaces in the LMA are quite remote from residences, metered spaces may function to a degree as resident spaces, because vehicles with resident stickers are exempt from the two-hour limit which applies to most vehicles in metered spaces. Since the Boston Transportation Department is very concerned about on-street parking supply and demand throughout the city, further study will surely be required before implementation of this proposal is approved.

On Brookline Avenue, removal of all 168 curbside parking spaces between the Fenway and the Brookline town line would allow for five travel lanes -- two through lanes in each direction and exclusive left-turn lanes at most intersections. These left-turn lanes have enormous potential to improve through traffic flow, because left-turning vehicles would otherwise block a through lane while waiting for an acceptable gap in the opposing traffic. Projected 1992 left-turn volumes on Brookline Avenue are more than high enough to justify exclusive left-turn lanes, as shown in Table 1. Exclusive left-turn lanes also improve traffic safety by eliminating the need for through traffic caught behind a left-turn queue to merge with through traffic in the right lane.

TABLE 1
FORECAST 1992 LEFT-TURN VOLUMES

		Number of Left-Turning Vehicles	Total Approach Volume	Percent Turning Left	Opposing Volume
Brookline Ave. Southbound					
at Longwood Avenue	(AM)	331	1,058	31%	1,004
	(PM)	217	1,132	19%	804
Brookline Ave. Southbound					
at Francis Street	(AM)	232	658	35%	1,325
	(PM)	91	1,135	8%	721
Brookline Ave. Northbound					
at Riverway	(AM)	326	1,137	29%	362
	(PM)	117	550	21%	922

On Longwood Avenue, parking is already prohibited on the four-lane segment between Brookline Avenue and Blackfan Street. On the remaining segments within the LMA, removal of all 59 on-street parking spaces would make possible a two-lane eastbound approach to Brookline and Huntington Avenues at all times of the day. Currently, there are metered spaces on these approaches and signs indicating a peak period parking ban. This system's disadvantages are: (1) only one approach lane is available during the busy midday period, and (2) drivers often park illegally at a meter during a restricted period because they assume that the presence of a meter means that parking is permitted.[4]

4/ "Longwood Avenue On-Street Parking Spaces Removal Feasibility Study," Memorandum from VHB to Children's Hospital, July 31, 1987.

The benefits of removing parking on Longwood Avenue would not be confined to the two intersections mentioned above. Traffic flow and safety would also be enhanced at the unsignalized intersections of Longwood Avenue with Plymouth Street, Pilgrim Road, Avenue Louis Pasteur and Palace Road. At these locations, the provision of one wide travel lane in each direction would enable through traffic to bypass turning vehicles. The removal of parking also facilitates truck turns at street intersections and driveways.

An alternative to providing two wide travel lanes on the segments of Longwood Avenue which are not wide enough for four lanes would be to provide three narrow lanes, the center lane being reserved for left turns. This alternative is less advantageous because it provides only slightly more room for bypassing left-turning vehicles while making it much harder to bypass right-turning vehicles and stopped vehicles. Exclusive left-turn lanes on Longwood Avenue are needed only at its intersections with Brookline and Huntington Avenues.

At Huntington Avenue's intersections with Francis Street, Longwood Avenue and Ruggles/Louis Prang Street, a daytime parking ban applied to approximately ten parking spaces on each Huntington Avenue approach would reduce delays by allowing the creation of exclusive right-turn lanes. The exact number of spaces on each approach would need to be determined after further study of parking demand. Based on anticipated right-turn volumes, the need for right-turn lanes appears to be greatest on the southbound approach to Longwood Avenue and on the northbound approach to Ruggles/Louis Prang Street, particularly the latter. On the northbound approach to Longwood Avenue, the removal of two or three spaces would be adequate.

On the 31-foot wide segment of Louis Prang Street between Vancouver Street and Huntington Avenue, eastbound traffic is confined to a single 9-foot lane while parking is provided along the north curb. Though the number of eastbound left-turns at Huntington Avenue is very small (one per cycle in the peak hour), eastbound through drivers are significantly delayed by their inability to bypass left-turning traffic. Removal of about ten parking spaces along the north curb would allow the eastbound approach width to be increased to 19 feet, allowing eastbound through traffic to bypass left-turning vehicles.

Removal of the 42 resident permit spaces on Francis Street appears infeasible due to adverse impacts on neighborhood residents. However, based on earlier analyses conducted by VHB for Brigham and Women's Hospital as well as analyses undertaken for this study, removal of all remaining metered parking spaces on the north side of Francis Street adjacent to the hospital is feasible and would improve traffic flow and safety.

B9. Enhance the Effectiveness of the Longwood Avenue/Riverway Signal

With the traffic volumes forecast for 1992, and in the absence of any improvements, the Longwood Avenue/Riverway intersection would operate at Level of Service "F" in both peak hours. Under existing conditions, the analysis indicates Level of Service "D" in the AM peak hour and "E" in the PM peak hour, but actual conditions are even more unfavorable because the computer analysis technique ignores the delays caused by the lack of coordination with the nearby Longwood Avenue/Chapel Street signal.

Deficiencies at this intersection arise from the need for four phases, including an exclusive pedestrian phase and a separate phase for northbound Riverway left-turns. Forecast volumes can be carried at Level of Service "D" instead of "F" in

both peak hours if the signal phasing is altered to allow northbound left-turns (and eastbound right-turns) to move while pedestrians travel in the protected northside and eastside crosswalks. Because these movements do not conflict, pedestrians in these two crosswalks would have all the benefits of an exclusive pedestrian phase. Under this scenario, the existing northbound left-turn storage bay would be lengthened as far as the existing roadway width allows, and northbound left-turns would be halted during the Riverway's through traffic phase to permit use of the west crosswalk. Pedestrians using the west crosswalk during this phase would conflict only with the two or three southbound drivers per minute who turn right on Longwood Avenue. Since these drivers have a good view of the crosswalk, the conflict does not present significant safety problems.

The drawback of this solution is that the south crosswalk would be discontinued. Signs, complemented if needed by bollards and chains, would be used to direct pedestrians to the north crosswalk, where a fully protected phase would be provided for crossing the Riverway. For a pedestrian whose origin and destination both lay on the south side of Longwood Avenue, walk distance would be increased by about 80 feet. Because Longwood Station, which generates much of the pedestrian volume in the area, lies north of Longwood Avenue, it is estimated that only 15-20 percent of all pedestrians crossing the Riverway at the Longwood Avenue would have to walk the extra 80 feet.

The signal's cycle length would be reduced from 160 to 90 seconds to allow coordination with the signals at Chapel Street and Kent Street in Brookline, both of which operate on 90-second cycles. The cycle time reduction would also benefit pedestrians by reducing the "Don't Walk" intervals from 138 seconds to 68 seconds and by providing 40 crossing opportunities per hour instead of 22.

Coordination with the signals in Brookline is an essential part of this strategy. Coordination has been determined to be feasible, but it requires complete replacement of the Brookline signal equipment, some of which dates to the 1930's. Because of the short distance (300 feet) between the Riverway and Chapel Street signals, coordination is critical to the success of any plan to enhance the effectiveness of the Longwood Avenue/Riverway signal.

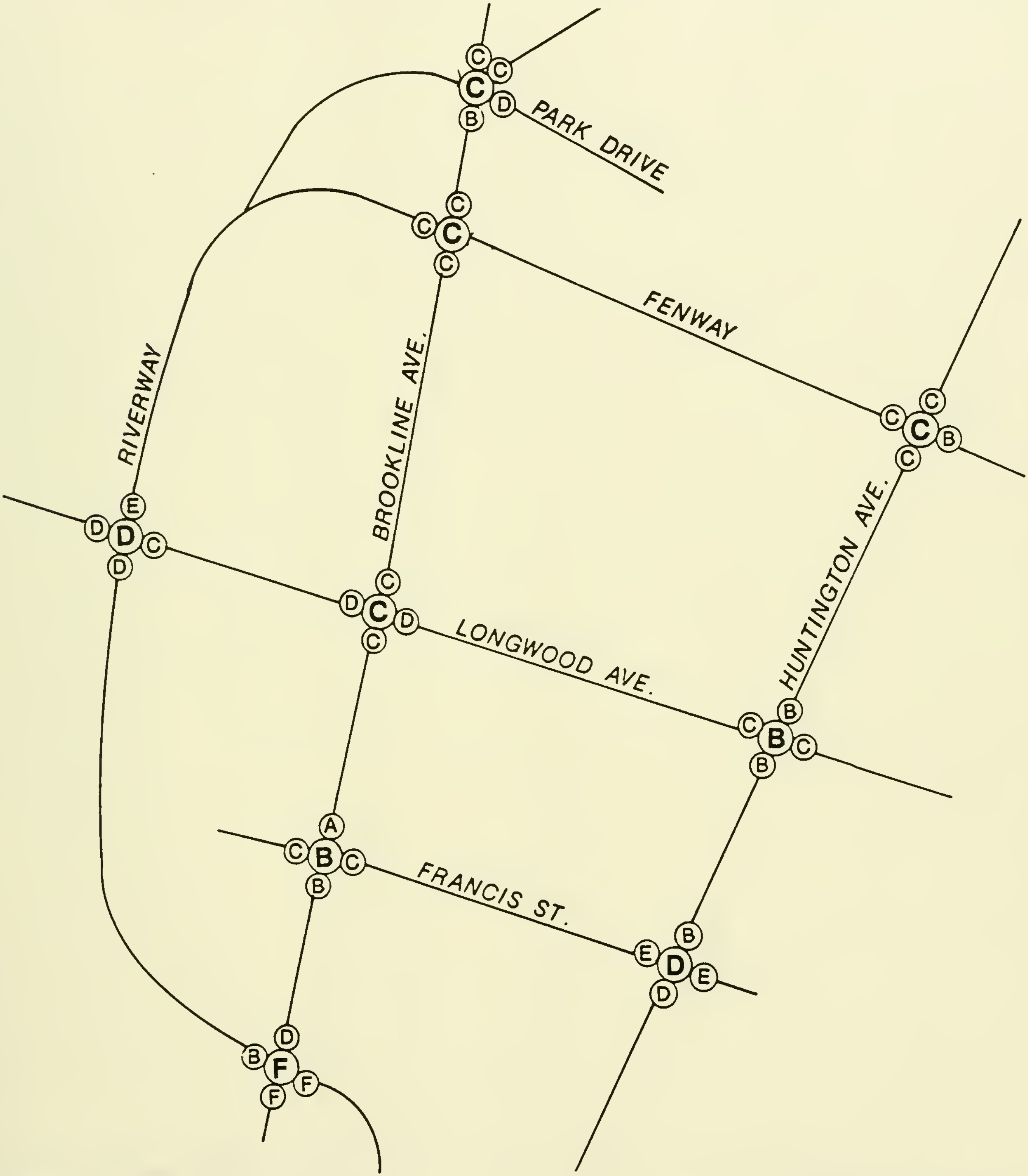
B10. Reopen Worthington Street

Before it was converted to a private way, the northern portion of Worthington Street linked Longwood Avenue to the southbound lanes of Huntington Avenue. Reopening Worthington Street would provide a shortcut for drivers who currently turn sharp right from Longwood Avenue eastbound onto Huntington Avenue southbound (see Figure 2). Also, the diversion of these vehicles would reduce delay at the Longwood Avenue/Huntington Avenue intersection. However, since only about 50 eastbound vehicles are forecast to turn right at that location in the peak hour, the aggregate travel time benefits would be minimal.

It is possible that additional development beyond the five-year time frame, together with implementation of the Riverway-Brookline one-way pair, could increase the attractiveness of this option.

Conclusion: Level-of-Service Analysis

Figures 8 and 9 present the level of service effects of the roadway improvements, including removing parking as described above as well as optimally reallocating available green signal time and roadway width. Reopening Worthington Street was not assumed in the analysis. To facilitate signal coordination and



A.M. Peak Hour Level of Service With Other Roadway Improvements

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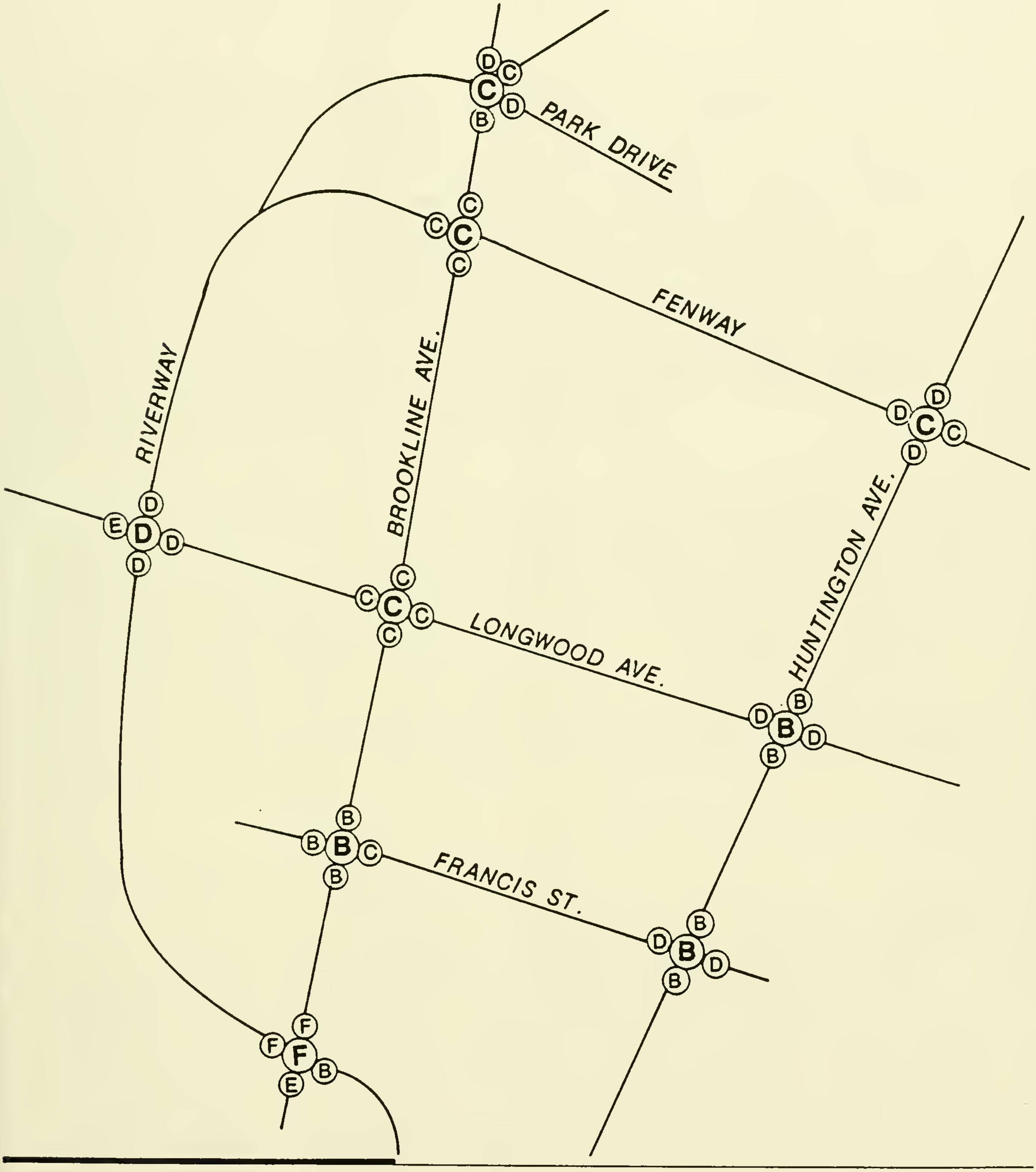
Not to Scale

Fig. 8



P.M. Peak Hour
Level of Service
With Other
Roadway Improvements

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Consulting Engineers & Planners
60 Birmingham Parkway, Boston, MA 02135

Not to Scale

Fig. 9

prevent excessive pedestrian wait times, the existing 100-second cycles were used at the Huntington Avenue intersections, and 90-second cycles were used for all other signals. As shown in the figures, the roadway improvements proposed in this section, together with the northbound left-turn restriction at the Huntington Avenue/Longwood Avenue intersection discussed in the following section on circulation changes, can restore most analyzed intersections to Level of Service (LOS) "C" or better. Only the Riverway/Brookline Avenue intersection would remain deficient, with LOS "F" in both peak hours.

Table 2 indicates the level-of-service (LOS) changes that result from the other roadway improvements. Compared to the 1992 conditions forecast in Technical Memorandum #2, the roadway improvements involving no construction can reduce the number of intersection deficiencies (LOS "E" and "F") from six to one in each peak hour. With the exception of the Brookline Avenue/ Riverway intersection, which remains at LOS "F" in both peak hours, all analyzed intersections show improved level of service in the PM peak hour.

C. CIRCULATION CHANGES

Roadway circulation systems are defined by the set of regulations governing which movements are permitted on the various roadways and intersections. Where traffic is light, two-way traffic is permitted on all roadways, and all turns are permitted at all intersections. Where traffic is heavy, on the other hand, movement restrictions such as one-way streets and turn prohibitions are often employed to reduce congestion and enhance traffic safety. The main advantage shared by one-way street patterns and

TABLE 2
EFFECTS OF OTHER ROADWAY IMPROVEMENTS

Intersection	AM Peak Hour						PM Peak Hour					
	V/C Change		Delay Change		LOS Change		V/C Change		Delay Change		LOS Change	
	From	To	From	To	From	To	From	To	From	To	From	To
Brookline Ave./Boylston St./Park Dr.	0.84	0.78	21	18	C	C	0.95	0.82	34	20	D	C
Brookline Ave./Fenway	0.71	0.76	29	17	D	C	0.74	0.71	30	16	D	C
Brookline Ave./Francis St.	1.56	0.60	183	11	F	B	0.84	0.72	30	15	D	B
Brookline Ave./Longwood Ave.	1.33	0.91	170	24	F	C	1.05	0.88	102	23	F	C
Brookline Ave./Riverway	1.20	1.34	60+	155	F	F	1.20	1.18	60+	67	F	F
Huntington Ave./Francis St.	0.90	1.01	92	32	F	D	0.90	0.62	59	14	E	B
Huntington Ave./Longwood Ave.	1.05	0.64	85	11	F	B	1.02	0.82	86	14	F	B
Huntington Ave./Ruggles St.	0.80	0.72	23	18	C	C	1.24	0.87	166	25	F	C
Longwood Ave./Riverway	0.98	1.00	99	38	F	D	1.23	1.00	122	34	F	D

Note: V/C is the volume-to-capacity ratio, Delay is the delay (in seconds) incurred by the average driver, and LOS is the intersection level of service, a reflection of average delay. Forecast 1992 traffic volumes are assumed in all cases.

left-turn restrictions is that both regulations eliminate the conflicts between left-turning vehicles and opposing through traffic, thereby improving safety and removing a significant source of delay.

Movement restrictions generally reduce the travel time of the average driver, but may increase or decrease travel time for trips to or from points adjacent to the restricted roadway or intersection. For this reason, movement restrictions work best where the percentage of through traffic is highest.

Nine circulation changes are evaluated in this report:

C1. Riverway-Brookline Avenue one-way pair.
C2. Northbound left-turn restriction at Huntington and Longwood Avenues.
C3. Designate Longwood Avenue westbound and Francis Street eastbound.
C4. Designate Longwood Avenue eastbound and Francis Street westbound.
C5. Southbound left-turn restriction at Brookline and Longwood Avenues.
C6. Designate Longwood Avenue westbound from Avenue Louis Pasteur to Brookline Avenue.
C7. Implement reversible lanes on Brookline Avenue.

Because of their similarity, C3 and C4 are analyzed together, as are C5 and C6.

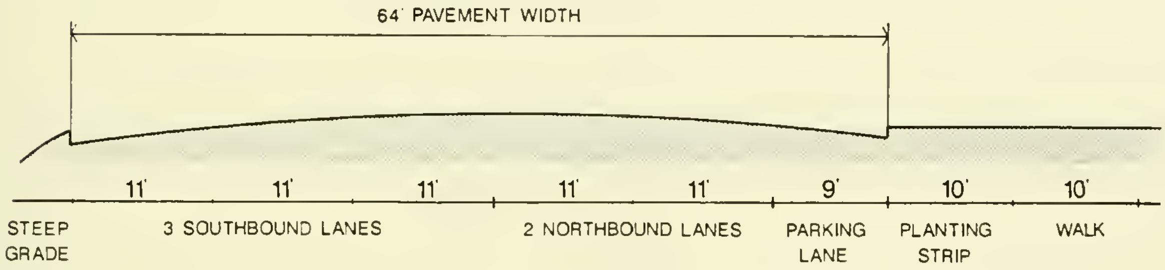
C1. Riverway-Brookline Avenue One-Way Pair

In the Longwood Medical Area, through traffic percentages are highest on the Riverway, Huntington Avenue and Brookline Avenue, in that order. Since Huntington Avenue has a median reservation,

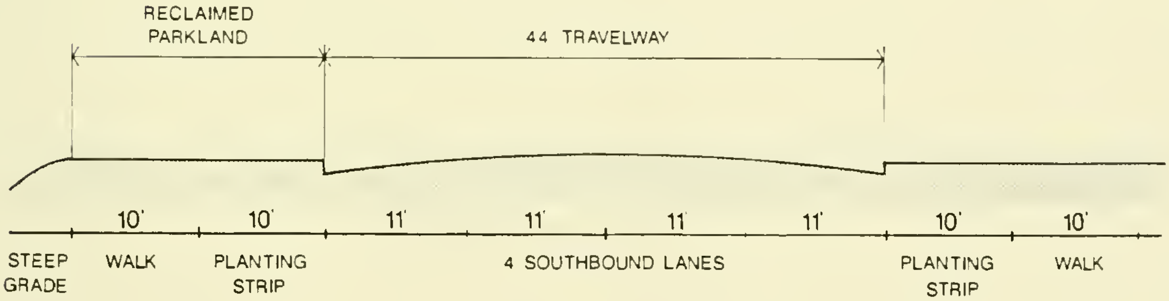
only Brookline Avenue and the Riverway should be considered for one-way designations. The 1975 transportation study commissioned by MASCO recommended that Brookline Avenue be designated one-way northbound from the Riverway to Park Drive, and that the Riverway be designated one-way southbound from Park Drive to Brookline Avenue. Because the Riverway is a Metropolitan District Commission (MDC) parkway restricted to non-commercial vehicles, the 1975 study recommended a southbound contraflow lane on Brookline Avenue to carry trucks and buses. Emergency vehicles would also use the contraflow lane.

A comprehensive analysis of the Riverway-Brookline Avenue one-way pair was conducted for this study. Unlike the 1975 proposal, the alternative evaluated here requires no roadway widening and no taking of MDC parkland. In fact, it would allow the creation of additional parkland with a new pedestrian sidewalk along the west side of the Riverway north of Longwood Avenue, as shown in Figure 10.

Under this proposal, the Riverway would be restriped for four southbound lanes, each with a minimum width of 11 feet. Parking along the east curb north of Plymouth Street could be retained. On Brookline Avenue, which is 59 feet wide, parking would be prohibited at all times in the southbound contraflow lane along the west curb. Parking along the east curb would be prohibited between 6:30 AM and 7:00 PM in order to provide adequate northbound capacity during the day. As shown in Figure 11, Brookline Avenue would carry four 11-foot northbound lanes south of Longwood Avenue. At Longwood Avenue, the left-most northbound lane would be for left turns only, and the segment north of Longwood Avenue would carry three northbound lanes all the way to Park Drive. The southbound contraflow lane would be at least 20 feet wide, so that trucks and emergency vehicles could bypass stopped buses, except for the 15-foot wide segment between



Existing



Proposed

Typical Riverway Section North of Longwood Avenue

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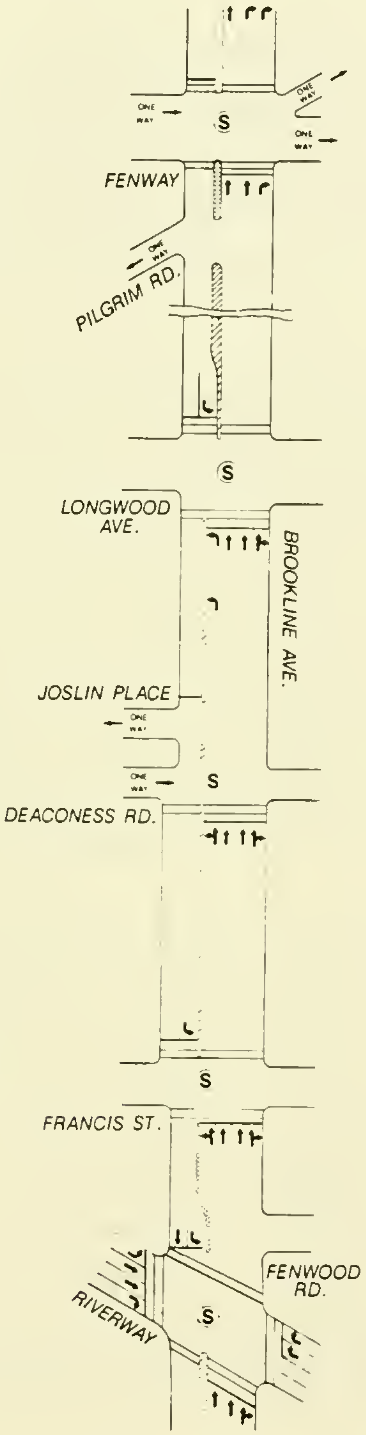
Not to Scale

Fig. 10



Proposed Brookline Avenue Section

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0 75 150
SCALE IN FEET

Fig. 11

Longwood Avenue and Deaconess Road, where no bus stops would be located. At the Longwood Avenue intersection, where many southbound buses turn left, two 12-foot approach lanes would be provided in the contraflow lane to separate left-turn movements from through southbound traffic.

To improve land access in the one-way scenario, several minor changes to the existing circulation system (see Figure 2 in Chapter I) would be made. Autumn Street would be changed from one-way northbound to one-way southbound. An available option, not analyzed in this study, would be to create a contra-flow northbound local-traffic lane on the Riverway from Short Street to Park Drive to improve land access for Wheelock and Simmons Colleges, the Winsor School, and Riverway residences. Another option, which appears beneficial but was not assumed in the analysis, is to allow two-way traffic on a short segment of Pilgrim Road, as discussed in item #C8.

Analysis of the one-way pair strategy involved review of the five-year traffic growth projections to identify those traffic movements which would be prevented by the one-way pair scenario. These volumes were reassigned to the available alternate routes. For example, all through traffic originally projected to flow northbound on the Riverway was reassigned to Brookline Avenue. Traffic originally projected to travel from the Sears area to Blackfan Street via Brookline Avenue was allocated half to the Riverway and half to Avenue Louis Pasteur. The resulting volumes were analyzed to estimate the level-of-service impacts of the one-way plan.

The analysis concluded that the one-way pair would have substantial traffic level-of-service (LOS) benefits on both Brookline Avenue and the Riverway. All intersection deficiencies (LOS "E" and "F") would be eliminated in both peak hours. LOS

"C" or better would prevail in the PM peak hour at all signalized intersections along Brookline Avenue and the Riverway, and in the AM peak hour at all the same intersections except two (Brookline Avenue/Longwood Avenue and Brookline Avenue/Riverway), which would operate at LOS "D." The detailed level of service projections are presented in Figures 12 and 13.

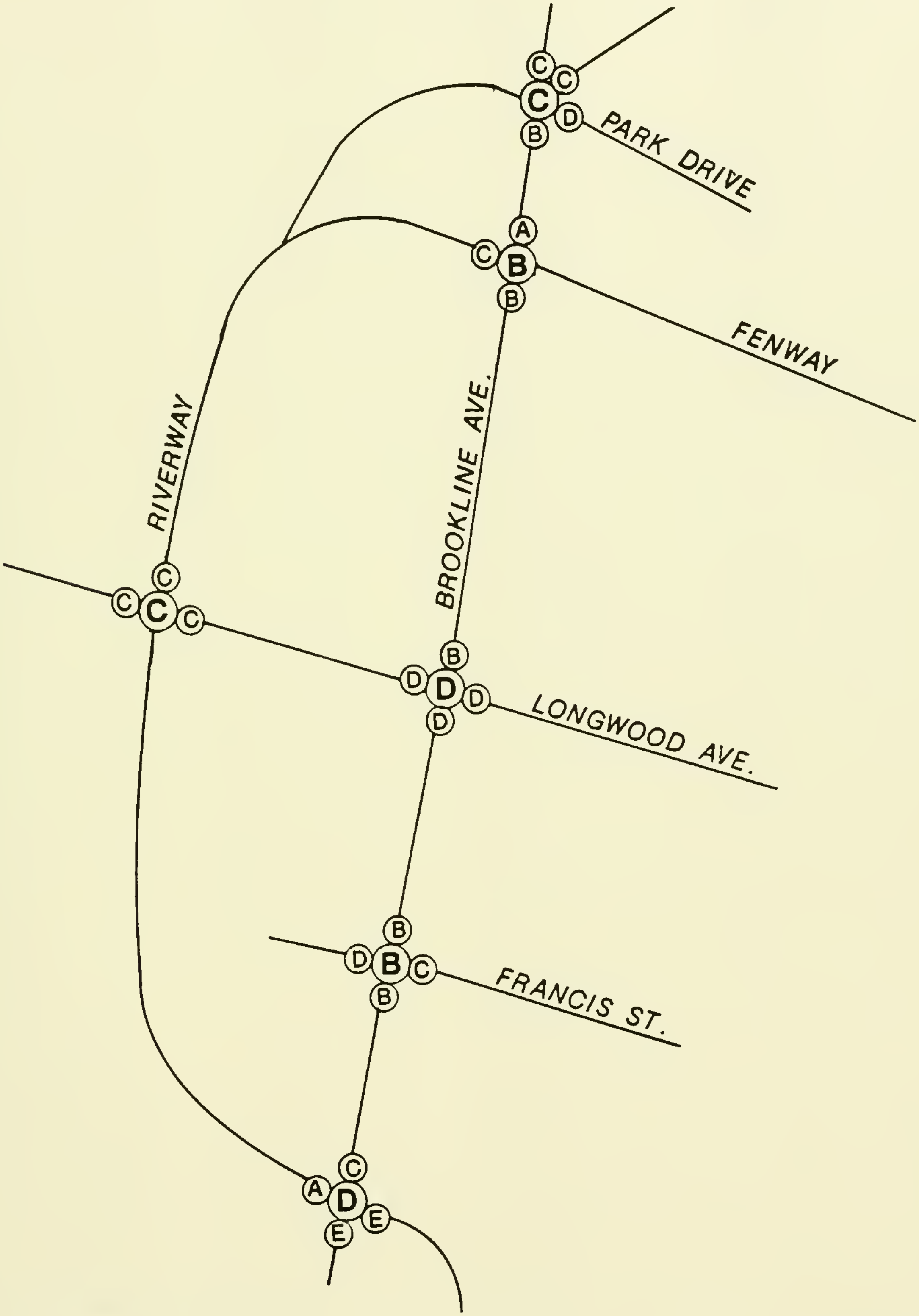
Comparing the one-way pair with the results that could be achieved through the roadway improvements analyzed in the previous section, the one-way pair has several significant advantages (see Table 3):

- It eliminates all projected signalized intersection deficiencies, while the other roadway improvements alone leave LOS "F" at the Riverway/Brookline Avenue intersection during both peak hours. Queues from that intersection might extend back into the LMA and cause delays at other locations.

- It eliminates the merge of northbound Riverway with eastbound Park Drive, thereby reducing congestion at the Fenway/Brookline Avenue signal. The analysis shows an improvement from LOS "C" to LOS "B" at this location, but the actual improvement may be even greater because the analysis techniques underestimate the delays caused by the merge.

C2. Northbound Left-Turn Restriction at Huntington and Longwood Avenues

A left-turn restriction from northbound Huntington Avenue onto westbound Longwood Avenue would reduce delay at this location. Vehicles currently making left or U-turns at Longwood would be forced to make U-turns at the next intersection (Evans Way) and return to Longwood Avenue. Since the Evans Way inter-



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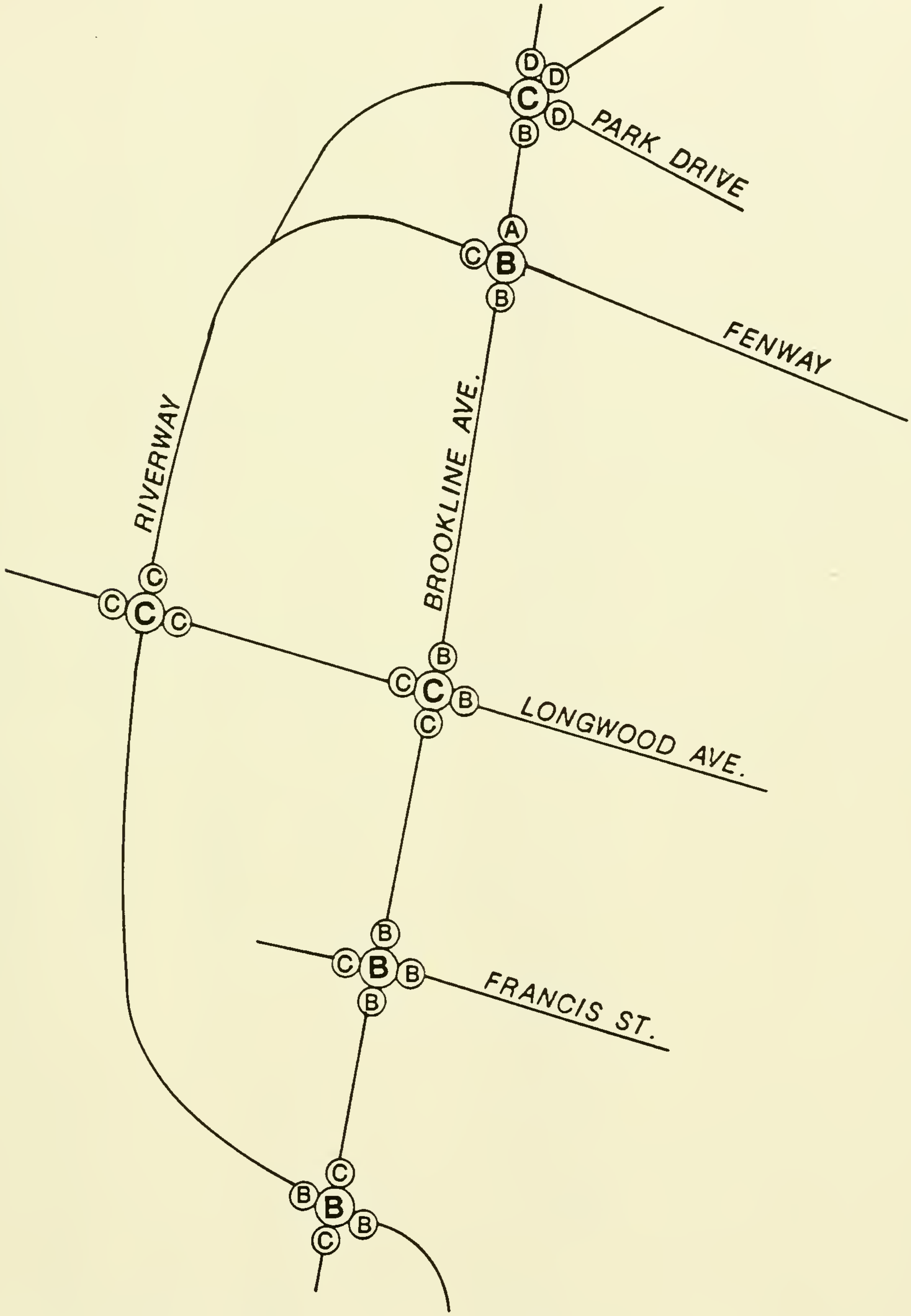
Not to Scale

Fig. 12

A.M. Peak Hour
Level of Service
With One-Way Pair



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P.M. Peak Hour Level of Service With One-Way Pair

Not to Scale

Fig. 13

TABLE 3
COMPARISON OF ONE-WAY PAIR WITH OTHER ROADWAY IMPROVEMENTS

Intersection	V/C AM	V/C PM	Delay (sec) AM	Delay (sec) PM	V/C AM	V/C PM
Brookline Ave./Boylston St./Park Dr.:						
One-Way Pair	0.76	0.90	18	23	C	C
Other Roadway Improvements	0.78	0.82	18	20	C	C
Brookline Ave./Fenway:						
One-Way Pair	0.70	0.60	13	12	B	B
Other Roadway Improvements	0.76	0.71	17	16	C	C
Brookline Ave./Francis St.:						
One-Way Pair	0.85	0.58	15	13	B	B
Other Roadway Improvements	0.60	0.72	11	15	B	B
Brookline Ave./Longwood Ave.:						
One-Way Pair	0.98	0.89	29	19	D	C
Other Roadway Improvements	0.91	0.88	24	23	C	C
Brookline Ave./Riverway:						
One-Way Pair	1.04	0.65	33	9	D	B
Other Roadway Improvements	1.34	1.18	155	67	F	F
Longwood Ave./Riverway:						
One-Way Pair	0.73	0.82	17	17	C	C
Other Roadway Improvements	1.00	1.00	38	34	D	D

Note: V/C is the volume-to-capacity ratio, Delay is the delay (in seconds) incurred by the average driver, and LOS is the intersection level of service, a reflection of average delay. Forecast 1992 traffic volumes are assumed in all cases.

section already has an exclusive left-turn phase, a simple retiming of this signal could accommodate the additional U-turns. Critical Lane Movement analysis assuming 1992 forecast volumes plus the rerouted traffic shows that the Huntington Avenue/Evans Way intersection would operate at Level-of-Service "C" in both peak hours despite estimated total left- and U-turn volumes of 600 in the AM peak hour and 385 in the PM peak hour.

As detailed at the conclusion of the previous section on other roadway improvements, the northbound left-turn prohibition, combined with reallocations of available pavement width and green signal time, results in Level-of-Service "B" in both peak hours at the intersection of Huntington and Longwood Avenues, as compared with Level-of-Service "D" (existing) and "F" (forecast) in both peak hours. The left-turn restriction also represents a safety improvement for pedestrians crossing Longwood Avenue in the west crosswalk because right-turning drivers have a better view of conflicting pedestrian traffic than have left-turning drivers.

C3-C4. Longwood Avenue-Francis Street One-Way Pair

Two different proposals to make Longwood Avenue and Francis Street into a one-way pair had been suggested. Under one scenario, Longwood Avenue would flow west while Francis Street flowed east; under the other scenario, the circulation would be reversed. Although both plans, particularly the former, would have demonstrable traffic flow benefits, both would significantly increase traffic on residential parts of Fenwood Road. Because this adverse impact was considered unacceptable, the proposals were not studied further.

C5-C6. Reduce Left-Turn Volume at Brookline and Longwood Avenues

At the intersection of Brookline and Longwood Avenues, significant delays are attributable to the high southbound left-turn volumes (275 existing, 331 forecast in the AM peak hour). One way to accommodate these turns is to provide an exclusive left-turn lane, as discussed in the previous section on roadway improvements. An alternative proposal is to prohibit southbound left turns at that location, diverting some traffic to the Fenway and Avenue Louis Pasteur, where surplus capacity is available. Drawbacks of this proposal are: (1) some traffic would turn left instead at the Brookline Avenue/Deaconess Road intersection, creating queues there, (2) an exemption for buses and emergency vehicles would be necessary, lessening the benefits of the restriction, and (3) trucks, already banned from the Fenway, would be diverted to residential portions of Francis Street. An exemption for trucks would further lessen the benefits of the restriction and would make it more difficult to enforce. A related proposal, to address the left-turn problem by making Longwood Avenue one-way westbound from Avenue Louis Pasteur to Brookline Avenue, would have the same disadvantages.

C7. Implement Reversible Lanes on Brookline Avenue

A proposal for reversible lanes on Brookline Avenue was found to be disadvantageous because, in each hour of a typical weekday, northbound and southbound flows are approximately equal. Reversible lanes are useful only when the percentage of traffic flowing in a given direction varies greatly from one time period to another.

C8. Make Pilgrim Road Two-Way From Joslin Place to Deaconess Garage

Pilgrim Road between Longwood Avenue and Francis Street currently functions as a one-way southbound collector roadway. The segment between Deaconess Road and Francis Street is expected to be closed permanently next year, after which time the short remaining segment of Pilgrim Road will function as a local land access roadway, primarily serving the 761-space New England Deaconess Hospital Garage. If no circulation changes are implemented in the LMA, most garage traffic arriving from the south will travel via the Riverway and enter from Autumn Street, while most traffic from the other directions will use Longwood Avenue and Pilgrim Road.

This proposal would provide an alternate route to the garage from the south. Drivers could use Brookline Avenue instead of the Riverway, turn left at Joslin Place, and right (north) on Pilgrim Road. In the absence of other circulation changes, this proposal has neither significant advantages nor significant disadvantages.

However, if the Riverway-Brookline Avenue one-way pair were implemented, garage traffic from the south would generally travel via Brookline Avenue instead of the Riverway, turn left on Longwood Avenue, and turn left again to access the garage. Under this scenario, the Pilgrim Road proposal, while still not critical, would become quite useful. It would provide a shortcut for these drivers and remove most of them from the Brookline Avenue/Longwood Avenue intersection.

C9. Close Francis Street to Through Traffic

Erecting a barrier on Francis Street between Vining Street and Saint Albans Road would benefit Francis Street residents by reducing traffic on Francis Street. Emergency vehicle access could be provided by means of a "mountable" barrier. However, most of the traffic diverted from Francis Street would use Fenwood Road, resulting in sharp increases in Fenwood Road traffic. Since Fenwood Road has more residences than Francis Street, the strategy would have a negative impact on the Mission Hill neighborhood.

D. TRAFFIC REDUCTION STRATEGIES

Twelve of the improvement strategies evaluated were classified as traffic reduction strategies. Most of these strategies are designed to make driving (especially driving alone) to the LMA less attractive, or to make traveling to the LMA by public transportation more attractive. These are:

D1. Raise parking fees for employees.
D2. Provide and market transit subsidies for employees and visitors.
D3. Subsidize LMA employees' parking fees at outlying MBTA stations.
D4. Establish ridesharing objectives.
D5. Start an "Alternatives to Driving Alone to the LMA" campaign.
D6. Improve MBTA service on the Riverside and Arborway lines.
D7. Improve MBTA service to Ruggles Station and Roxbury-Dorchester.
D8. Provide a MASCO shuttle to Ruggles MBTA Station.
D9. Provide a MASCO shuttle to Longwood MBTA Station.

Two additional strategies are intended to shift vehicle-trips away from the most congested locations or time periods:

D10. Increase off-site parking facilities for employees.
D11. Coordinate a voluntary staggered work hours program.

The final strategy seeks to reduce the need for travel:

D12. Subsidize or build nearby housing for LMA employees.

All 12 strategies are evaluated in turn below.

D1. Raise Parking Fees for Employees

There is ample evidence that parking fees are the most important factor in a worker's decision to drive alone to work.[5] At worksites served by public transportation service, high parking fees cause the majority of workers to use that service even if its quality is poor. At worksites not served by public transportation, high parking fees are the most effective incentive for carpool formation even if carpools are not exempt from the fees.

In the LMA, higher employee parking fees would unquestionably lead to a marked reduction in the percentage driving alone to work. In addition, higher parking fees could provide the funds for transportation system improvements. Currently, LMA institutions subsidize employee parking very heavily - in the 1987 MASCO

5/ Don H. Pickrell and Donald C. Shoup, "Employer-Subsidized Parking and Work-Trip Mode Choice," Transportation Research Record 786, Transportation Research Board, National Academy of Sciences, Washington, D.C., 1980.

survey, one LMA hospital estimated its annual parking subsidies at over $400,000, and this may be a conservative estimate. Raising parking fees would reduce those subsidies, freeing the funds for a variety of alternative uses.

Employee parking in LMA garages is especially heavily subsidized. Employees pay $3 to $6 per day on a monthly basis, while patients pay $10 to $15 per day. Reducing the employee parking subsidies at on-site garages, as recommended in a 1986 parking study conducted for MASCO,[6] would lead to increased vehicle occupancy at those garages as well as increased use of alternative travel modes.

From the perspective of the LMA institutions, one obstacle to reducing employee parking subsidies is the need to attract and retain qualified workers while competitors subsidize their employees' parking. Although the suburban competitor is often cited, the LMA institutions' most significant competitors in the labor market are, in fact, each other. It is unrealistic to expect one LMA institution to eliminate parking subsidies while its LMA competitors continue to subsidize parking heavily. This problem can be overcome by central coordination of LMA parking policies, as discussed in the parking management section of this report. Through such coordination, employee parking subsidies could be reduced, and a portion of the funds saved could be used to provide more cost-effective employee benefits, so as to improve the LMA institutions' competitive edge over suburban institutions.

6/ Jane Howard, "MASCO Institution Parking Waiting List Survey," Final Report, April, 1986.

Fringe benefits with positive effects on the transportation system include flexible work hours (discussed later as item #D11) and on-site employee recreational activities such as continuing education courses and physical fitness classes. Such activities reduce the concentration of worker arrival and departure times, thus relieving congestion on roadways and transit vehicles.

D2. Provide and Market Transit Subsidies for Employees and Visitors

While transit subsidies for visitors would be extremely difficult to administer, transit subsidies for employees are simple and effective. The Boston Transportation Department has recently adopted a policy of urging developers of new buildings to provide 25 percent monthly transit pass subsidies. Children's Hospital, which recently instituted a 25 percent subsidy on its pre-existing MBTA pass payroll deduction program found that enrollment increased 60 percent (from 500 to 800) as a result. The hospital spends about $60,000 annually on these subsidies, less than 15 percent of the amount it spends on parking subsidies. On a per-participant basis, the 25 percent transit pass subsidies cost the two hospitals which offer them only 31 cents per workday, while employee parking space subsidies per workday average $1.50 at off-site facilities and reach as high as $5.00 at on-site facilities. (New England Deaconess Hospital and the Harvard Medical School also subsidize MBTA passes.)

The effectiveness of increased transit subsidies would be greatest if coupled with a decrease in parking subsidies. This approach would maximize the incentive to switch from driving to mass transit, and would combat the employee's tendency to perceive the increased parking fees as simply an effort to reduce the employee benefit package.

D3. Subsidize LMA Employees' Parking Fees at Outlying MBTA Stations

For residents of outer suburbs, part of the price of a transit trip to the LMA is the price of parking at an MBTA station. Thus, it has been suggested that transit subsidy programs also include reimbursement of a portion of these MBTA parking fees. While this suggestion appears logical, it is quite impractical because MBTA parking fees are paid daily rather than monthly. It is much more convenient to distribute all transit subsidies through the MBTA monthly pass program.

The goal of this suggestion is increased use of transit, and the objective is to make parking at an MBTA station less expensive than parking in or near the LMA. The same objective can be achieved more effectively by increasing the parking fees in and near the LMA rather than by effectively lowering the employee's parking fee at the MBTA station.

D4. Ridesharing Program with Specific Objectives

In many parts of the country, substantial effort has been devoted to promoting ridesharing at multi-employer worksites such as the LMA.[7] Usually the site is a suburban or non-urban industrial park where transit service is poor or non-existent and where no single employer is large enough for an effective ridesharing program. When relatively few workers are employed at a company, the chances are slight that three (or even two) employees with compatible work schedules and preferences live

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7/ Booth, R. and Waksman, R., National Ridesharing Demonstration Program: Comparative Evaluation Report, Transportation Systems Center, Cambridge, MA, 1985.

near enough to each other to form a carpool. When several companies at adjoining worksites are combined into one ridesharing database, the chance of forming successful carpools improves.

MASCO currently operates a small-scale ridesharing program, but there appears to be considerable unrealized potential for an expanded ridesharing program, managed centrally by MASCO and supported by a coordinator at each LMA institution. The state-funded Caravan for Commuters, Inc., can provide valuable assistance, free of charge. An LMA-wide program would have more workers in its carpool matching database than would a program at a single institution. This would make possible more carpools, larger carpools, and perhaps a significant number of vanpools.

Potential obstacles to multi-employer ridesharing programs have been identified in national studies. Some employers in tight labor markets worry that if their employees carpool with employees of competing firms, labor force raiding will occur, or at least employees will demand benefits offered by competitors. Another obstacle applies to firms with non-union employees. National studies have found that these firms sometimes refuse to release the names and addresses of their employees to a ridesharing agency, for fear that the list will get into the hands of a union organizer. An LMA-wide ridesharing program would have to be sensitive to these potential concerns.

The most important component of a successful ridesharing program is the incentives. Since ridesharing is generally less convenient than driving alone, most commuters do not carpool unless they must pay substantially more to drive alone. The elimination of LMA employee parking subsidies would be ideal from a transportation viewpoint because, unlike most ridesharing incentives, this approach would enhance the attractiveness of all

alternative modes, including ridesharing, public transportation and walking. A substantial number of workers would carpool just to cut by half (or by two-thirds) their parking expenses. At the opposite extreme, if parking subsidies are maintained at current levels, it is doubtful that other ridesharing incentives would be sufficient to attract large numbers of commuters.

If employee parking subsidies are reduced but not eliminated, other ridesharing incentives likely to be effective include the following:

1. Assigning all employees in carpools of three or more members to their first choice employee parking facility. (Some parking facilities are much more convenient than others, and many LMA workers currently cannot park in their first choice location because of various priority considerations including shift, job category and seniority.)

2. Offering a 100 percent parking fee subsidy for carpools of three or more members.

Both of these incentives are likely to be effective, but the second incentive has two important drawbacks - it costs money, and it undermines the effectiveness of high parking fees in encouraging the use of public transportation and walking. Some portion of the carpools formed and subsidized will likely be comprised entirely of workers who currently commute by transit in order to avoid parking fees.

The formulation of specific goals and objectives is essential for many types of programs. In the case of an LMA ridesharing program, it is critical that the goal be vehicle-trip reduction rather than carpool formation. In areas with substantial public

transportation service, carpool formation (the traditional measure of effectiveness) does not assure that the carpoolers are commuters who would otherwise be solo drivers as opposed to transit riders. Objectives should be selected which are measurable and directly related to the goals. It would be necessary to set and review objectives on a year-by-year basis to make the program work.

D5. Start an "Alternatives to Driving Alone to the LMA" Campaign

MASCO currently supplies member institutions with route and schedule information for MASCO bus routes as well as a brochure entitled "Commuting Alternatives to the LMA." This MASCO role could be expanded to a full-service public relations campaign aimed at encouraging LMA commuters and visitors to take advantage of alternative modes of travel. Such a strategy would probably have a negligible impact by itself, but it could play an important supporting role in other traffic reduction programs. For example, a system of preferential parking for carpools would not be effective without a campaign to make commuters aware of the priority system.

Commuters (workers and students) would have to be the target audience for the campaign, because visitors are too difficult and expensive to reach and because visitors who are able to drive to the LMA are unlikely to consider using an alternative mode. Each institution, with the help of MASCO, could make commuter education a part of the employees' and students' first-day orientation.

D6. Improve MBTA Service on the Riverside and Arborway Lines

To improve service on the Riverside (D) and Arborway (E) branches of the MBTA Green Line, the MBTA could (1) restore full streetcar service to the Arborway, (2) acquire and deploy more Green Line cars, beyond the 100 cars currently on order, and (3) link available Green Line cars into longer trains to improve travel speeds.

Together, the Riverside and Arborway lines carry about two-thirds of all public transit riders to and from the LMA. It was estimated in Technical Memorandum #1 that, between 6:00 AM and 9:15 AM on weekdays, 3,300 riders arrive in the LMA on these two lines (including the Arborway Line's temporary replacement, Bus Route 39). The two lines provide direct service to Jamaica Plain, Brookline and Newton, where many LMA workers and students reside, and also connect in Downtown Boston with other rapid transit and commuter rail lines and express bus routes.

Arborway Line Restoration

In 1986 and 1987, the MBTA-sponsored Arborway Transit Study was conducted to identify and evaluate alternatives to restoration of the Arborway Line. The MBTA and its consultants evaluated eleven alternative strategies including, as Alternative #1, full restoration of the streetcar line with new vehicles and other capital improvements. The other ten alternatives involve various bus routings in conjunction with a shortened streetcar line terminating either at Brigham Circle or about 2/3 mile farther south, at Heath Street. These alternatives would have different effects on traffic conditions in the LMA.

The Arborway Transit Study report, dated December, 1987, shows clearly that full streetcar service restoration (designated Alternative #1) is the most costly option but also the most

effective strategy in terms of service quality and patronage. What most distinguishes Alternative #1 from all other alternatives is the provision of through (non-transfer) service from Jamaica Plain to Boston's central business district. As discussed in more detail in Section D7, the number of transfers required is a significant factor influencing the choice between public transportation and the automobile. Another advantage of Alternative #1, from the passenger's viewpoint, is that it offers a lower average fare.

Three of the alternatives evaluated would require Jamaica Plain residents to transfer at Heath Street to reach the LMA. This transfer would have a marked effect on the mode choice of LMA commuters and make the LMA a less attractive place to work for Jamaica Plain residents.

The remaining seven alternatives, including the one involving a bus loop through the LMA, would not require LMA riders to transfer any more than the restored streetcar service. Still, the streetcar's superior capture rate for downtown trips benefits LMA passengers by enabling (in fact, requiring) the MBTA to provide increased service frequency to accommodate the demand. The improved frequency further enhances patronage.

The Arborway Transit Study report provides sufficient data to permit a rough estimate of the effects of streetcar service restoration on LMA traffic conditions in the morning peak hour. Compared with Alternative #1, the seven alternatives which require transfers for downtown trips but not for LMA trips would probably add between 50 and 100 AM peak hour vehicle trips to one or more LMA arterials in 1992. The three alternatives which require transfers for LMA trips as well as downtown trips would likely add between 100 and 150 AM peak hour vehicle trips to LMA arterials and create a demand for 50 to 100 LMA parking spaces.

Additionally, LMA traffic operations are directly affected by the buses and streetcars. The Arborway Transit Study team, focusing on Centre Street in Jamaica Plain, found no significant differences in the traffic impacts of the transit vehicles in the eleven alternatives. In the LMA, however, streetcars operate in Huntington Avenue's median reservation north of Brigham Circle, while buses operate in the traffic stream. The seven bus alternatives not requiring a transfer for LMA trips would add between 11 and 30 buses to Huntington Avenue in the AM peak hour, including both directions. One local bus has the same traffic impact as two to six passenger cars, depending on the location of passenger stops in relation to intersections. Thus the direct impact of the buses on traffic flow may be as great as the impact of the new automobile trips generated by the selection of an alternative other than full streetcar service restoration.

As noted earlier, Alternative #1 is the most costly of the eleven analyzed. However, figures from the MBTA Advisory Board show that the Arborway Line in 1985, when full streetcar service was last provided, had a much lower cost per passenger than either of the other two local-service branches ("B" and "C") of the Green Line.

Other Green Line Improvements

Technical Memorandum #1 documented some of the service deficiencies encountered by passengers riding the Riverside ("D") Line to and from the LMA. Passengers boarding at Longwood Station frequently ride in overcrowded conditions and occasionally experience wait times exceeding ten minutes. The average wait time at Longwood Station is less than five minutes in both directions, and the average car is not overcrowded in either

direction, but overcrowding and prolonged wait times result from unreliability (i.e., uneven time intervals between trains). Unreliability, in turn, results from both a shortage of equipment and faulty scheduling and dispatching of available cars.

The MBTA has ordered 100 new Green Line cars, some of which are already in service, but equipment shortages will continue to occur as ridership increases, unless an additional purchase is made. These shortages increase the passenger load on the average car and, more importantly, exacerbate random delays, leading to severe overcrowding on certain trains. Because four Green Line branches share the same track in the Central Subway, an overcrowded train on any one branch line undermines reliability on all branches.

The most promising short-term strategy for improving reliability on all Green Line branches is to link available cars into fewer, longer trains. On the Arborway line, because streetcars lack a reserved median on much of the route, two-car trains are the maximum allowed. The Riverside line already can accommodate three-car trains but very few are deployed.

Regardless of the number of cars available, longer trains have several advantages: (1) A longer train can better accommodate without delay a sudden spurt of passengers, because the extra load is shared by more cars. (2) A system of two-car trains operating at 6-minute intervals would be less disturbed by an unexpected 2-minute delay (due to automobile traffic or any other cause) than would a system of one-car trains operating at three-minute headways. The same 2-minute delay would cause a 67 percent overload on a one-car train, compared with a 33 percent overload on a two-car train. (3) By operating fewer, longer trains, the MBTA could reduce congestion delays in the Central

Subway where all four branch lines share a single track in each direction. (4) After a breakdown or power outage has been rectified, the system's ability to recover is limited by the signal systems which require minimum distances between trains. The backlog of passengers could be moved through the signal systems more quickly on longer trains.

Because unreliable rather than infrequent service is the key problem on the Green Line, the fact that longer trains would increase average headways is relatively unimportant. The increase in headways would not necessarily increase average wait time, and the percentage of passengers waiting more than 10 minutes would most likely decline due to improved reliability.

With all four branch lines in service and unlimited freedom to select train length, the ideal balance between frequency and reliability would be achieved by operating 8-minute headways on each line throughout the day so that 2-minute headways would result in the Central Subway. The train length would be selected for each line and time period in response to ridership levels. Under this scenario, travel speeds on the Green Line would be almost as high during rush hour as they now are on Sunday mornings, trains in the Central Subway would arrive in a regular pattern (B,C,D,E,B,C,D,E), and recovery from power outages and breakdowns would be swift.

The ideal plan would require 3-car trains on the Arborway line and 4-car trains on the Riverside line. Platforms would have to be lengthened at surface stations, and separation of the Arborway line streetcars from general traffic would be desirable.

The latter is unrealistic, at least in the near future. Nevertheless, the line would benefit from a policy which (1) banned 1-car trains during rush hours, (2) set 8-minute headways as a goal for all lines at all times, and (3) required that no headways shorter than 6 minutes be operated except when all trains are at the maximum feasible length for that line.

D7. Improve MBTA Service to Ruggles Station and Roxbury-Dorchester

Just one mile from the intersection of Brookline and Longwood Avenues is a major public transportation facility, Ruggles Station. Although the MBTA Orange Line and a few commuter trains can be accessed at Ruggles, the station's bus service is by far the most significant to the LMA. Ruggles Station is served by 13 local bus routes, more than any station on the MBTA system except for Malden Center and Quincy Center. In the morning peak period, over 100 local bus arrivals per hour are scheduled at Ruggles, more than at any other station in metropolitan Boston.

Most of the LMA workers residing in the Roxbury-Dorchester-Mattapan area of Boston lie within walking distance of at least one of Ruggles Station's 13 bus routes. But only one of these routes, Route 47, continues beyond Ruggles Station into the LMA, and very few LMA workers live within walking distance of Route 47. For the other workers residing in that part of Boston, a bus trip to the LMA requires a transfer.

Many studies nationally have shown that transfers, even when no additional fare is involved, are a significant factor in people's decisions whether or not to use public transportation. Mode choice models used by the MBTA, which are calibrated using Boston data, indicate that the need to alight from the first bus,

wait just ten minutes for the second bus, and ride the second bus for ten minutes at no extra fare is as potent a deterrent to transit use as would be the need to stay on the first bus for an additional 50 minutes.

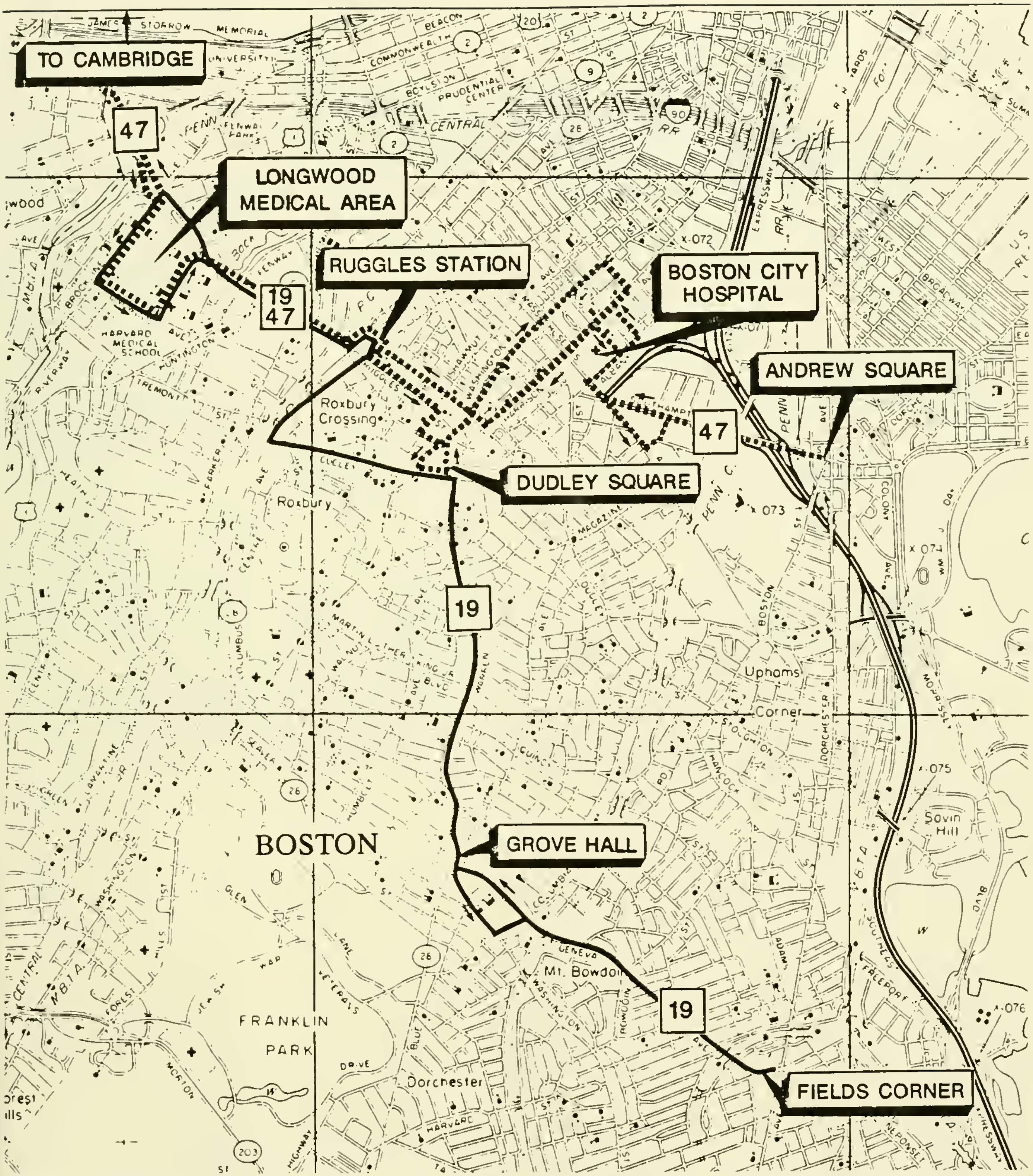
One obstacle to extending Ruggles Station bus routes into the LMA is that as bus routes become longer, particularly in congested areas, it is difficult to maintain reliable service. Another obstacle is the cost of the additional bus hours that are required, especially if a route with very frequent service is extended.

As part of this study, VHB analyzed eight Ruggles bus routes with potential for extension into the LMA. The suitability of extending each route was assessed based on three considerations: (1) the estimated number of LMA workers living within walking distance of the route, (2) the existing scheduled round-trip running time, and (3) the existing service frequency. The ideal candidate for extension would have a large number of LMA workers living near it, a short round-trip running time, and an existing peak hour service frequency of 10 to 15 minutes (which would be upgraded slightly if the route were extended).

Rating highest on the first consideration (LMA worker residence) was Route 28, which serves Mattapan, Grove Hall and Dudley Square. However, this route ranked lowest on the round trip time criterion, since its scheduled round trip time (80 minutes) is the longest of all the routes analyzed. Route 19, serving Fields Corner, Grove Hall and Dudley Square, scored in the middle range on the first criterion but topped the list on the second and third criteria. Route 19 thus appears to have the greatest potential for extension into the LMA.

In addition to eliminating the need to transfer for many LMA workers, extending Route 19 into the LMA along the path of the current Route 47 would also increase the number of buses servicing the Route 47 alignment. If the extension is planned properly, the resulting extra service would eliminate the need for Bus Route 47A. Route 47A refers to the extra buses currently operated during peak hours on the portion of Route 47 between the LMA and Boston City Hospital. If extended as shown in Figure 14, Route 19 would cover all of the Route 47A service area except for the short segment between Dudley Square and City Hospital, a segment served also by MBTA Bus Route 1.

The specific alternative analyzed is presented in Table 4. Route 47A would be dropped, with a savings of seven buses in the morning and four buses in the afternoon. The full Route 47 (Central Square, Cambridge, to Andrew Square, South Boston) would be upgraded from 20-minute headways in the morning and 17-minute headways in the afternoon to 15-minute headways in both time periods. In the morning, Route 19 headways would be upgraded from 13 minutes to 7.5 minutes to match the existing morning headways on Route 47A. In the afternoon, Route 19 headways would be upgraded from 20 minutes to 15 minutes, which would be an improvement over the 17-minute headways currently offered by Route 47A. As shown in Table 5, the advantages appear to outweigh the disadvantages.



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SCALE IN FEET

Proposed Bus Route Extension

Fig. 14

TABLE 4
RECOMMENDED BUS ROUTE CHANGES

	Existing			Proposed		
	19	47	47A*	19	47	47A*
AM Peak Period						
Cycle Time	52	100	50	75	90	N/A**
Headway	13	20	7.5	7.5	15	N/A
Buses Required	4	5	7	10	6	0
PM Peak Period						
Cycle Time	60	102	55	75+	105	N/A
Headway	20	17	17	15	15	N/A
Buses Required	3	6	4	5	7	0

* Route 47A is the supplemental rush hour service along the portion of Route 47 between the Brookline Avenue/Park Drive intersection in the LMA and Boston City Hospital.

** Not applicable.

+ In the PM only, westbound buses on Route 19 would shortcut the Route 47 alignment by following Fenway-Park Drive directly from Louis Prang Street to Brookline Avenue.

TABLE 5
ROUTE EXTENSION ANALYSIS

ADVANTAGES

A. LMA-Fields Corner Riders and LMA-Grove Hall Riders

1. Direct, non-transfer service (AM and PM)
2. Higher service frequency

AM: 7.5 minutes versus 13 minutes
PM: 15 minutes versus 20 minutes

B. LMA-Ruggles/Dudley Riders

1. Higher frequency in PM: 7.5 minutes vs. 8.5 minutes

C. LMA-Cambridge Riders and LMA-Andrew Square Riders

1. Higher service frequency

AM: 15 minutes versus 20 minutes
PM: 15 minutes versus 17 minutes

2. Easy-to-remember schedule in PM: every 15 minutes
3. Higher reliability in PM: extra round trip time allowed

D. MBTA System

1. Attract new riders traveling to/from LMA
2. Attract new non-LMA riders due to Route 19 frequency upgrade
3. Upgrading Route 19 will relieve crowding on Routes 23 and 28.
4. No cost in AM peak period.
5. Savings of one bus in PM peak period.

DISADVANTAGES

A. City Hospital Riders to/from LMA, Columbus Ave., or Talbot Ave.

1. Lower rush-hour frequencies on Route 47 near City Hospital

AM: 15 minutes vs. 7.5 minutes
PM: 15 minutes vs. 8.5 minutes

For all City Hospital area passengers not mentioned in Table 5, lower rush-hour frequencies on Route 47 near City Hospital would have no significant impact because the following substitute services are available:

- MBTA Bus Route 1 provides frequent service to the Dudley Square area and connects at Dudley with almost all Ruggles bus routes.
- MBTA Bus Route 1 connects with the Orange Line at Massachusetts Avenue Station.
- MBTA Bus Route 10 connects with all Ruggles Station commuter rail routes (and the Orange Line) at Back Bay Station.
- The City Hospital shuttle (for employees only) travels directly to Ruggles Station.

D8. Provide MASCO shuttle to Ruggles MBTA Station

MBTA Route 47 connects the LMA with Ruggles Station, but service on Route 47 is quite unreliable. The buses operate at irregular intervals, with the result that some are severely overcrowded while others are nearly empty, and passenger wait times are unpredictable. A MASCO shuttle to Ruggles has been suggested, in order to make transit a more attractive alternative for passengers who live near bus, rapid transit or commuter rail routes serving Ruggles Station.

While a MASCO shuttle would not eliminate the need to transfer, it would improve the quality of the trip between Ruggles Station and the LMA. A MASCO shuttle could be attractive also to passengers for whom riding MBTA buses raises security concerns.

The annual cost of a MASCO shuttle to Ruggles could exceed $100,000 or even $200,000, depending on the service frequency desired. However, it would be much less costly if it could be effectively combined with the existing MASCO shuttle (M4) serving the Prentiss Street parking facility. This possibility should be explored by MASCO. Another factor influencing the cost-effectiveness of an LMA-Ruggles shuttle is the possibility that LMA institutions might eventually move some back-room or research functions to the proposed Parcel 18 development near Ruggles Station. If so, a shuttle might serve internal trips as well as commuting trips.

Finally, the proposed expansion of commuter rail service at Ruggles Station could be made more successful if a MASCO shuttle were provided. Currently, only the Needham commuter rail line stops at Ruggles Station during peak hours. Approximately 1,400 LMA employees and students live in the three communities (Roslindale, West Roxbury and Needham) served by that line.

Station modifications have been proposed which would allow the other two commuter rail lines (Attleboro/Stoughton and Franklin) which pass through Ruggles Station to stop there. Approximately 1,200 LMA employees and students live in the twelve communities directly served by those two lines, and an additional 460 live in the eleven adjacent towns. Also, more than 600 Northeastern University employees and students live in the twelve communities directly served by the two lines, and the proposed Parcel 18 development will contribute further to the market potential of expanded commuter rail service at Ruggles Station.

MASCO should continue to explore the possibility of a full-service commuter rail station at Ruggles together with an LMA-Ruggles shuttle.

D9. Provide MASCO Shuttle to Longwood MBTA Station

LMA commuters who live along the Riverside Line (the "D" branch of the MBTA Green Line) are deterred from using public transportation by the relatively long walk from the major LMA worksites to the Riverside Line. To make mass transit a more attractive alternative, a MASCO shuttle between the LMA and Longwood Station has been suggested.

Analysis of this alternative included estimation of walking times between Longwood Station and several LMA locations. Assuming an average walking speed of 3 miles per hour, the following walk times to/from Longwood Station were estimated:

9 min.	Beth Israel Hospital main entrance (via Longwood Ave.)
6 min.	Beth Israel Hospital main entrance (via Olmsted Park)
11 min.	Brigham & Women's Hospital main entrance
9 min.	Children's Hospital main entrance
8 min.	Deaconess Hospital main entrance
12 min.	Harvard Medical School main entrance

Based on vehicular travel time data published in Technical Memorandum #1, shuttle travel time between Longwood Station and either Beth Israel Hospital or Harvard Medical School would be about five minutes, assuming no intermediate passenger stops. If passengers had to wait three to five minutes for the shuttle, it would provide no significant travel-time advantage over walking.

A more sophisticated approach to evaluating the shuttle is based on the observed mode choice effects of walking time, waiting time, riding time, and the number of transfers required on a transit trip. Based on the MBTA mode-choice model referred to earlier, the need to transfer at Longwood Station, wait three minutes for the shuttle, and ride the shuttle for five minutes to the worksite is as potent a deterrent to transit use as a ten-minute walk from Longwood Station to the worksite.

The shuttle could be attractive (especially in bad weather) if it were operated at high frequency and with a surplus of vehicles, so that by the time one vehicle departed, the next one would arrive. Passengers alighting from trains at Longwood Station would always find a shuttle vehicle waiting, and in just two or three minutes, they would be on their way. Vans or mini-buses would be needed because Longwood Station cannot accommodate full-size buses.

The shuttle would be costly because many drivers and vehicles would have to be dedicated to the service. Assuming that the shuttle operated five hours per day, 250 days per year, the cost would be approximately $40,000 annually per vehicle. Five or more vehicles would most likely be required. An infrequent service would be less expensive, but it would carry fewer riders. Since the walk distance is so short, most passengers would not be willing to wait at Longwood Station for a shuttle van unless they could see it approaching when they got off the train.

D10. Increase Off-Site Parking Facilities for Employees.

Increasing the number of off-site parking spaces is often suggested as a traffic reduction strategy. However, unless it is accompanied by a commensurate decrease in the number of on-site spaces, its effect may be just the opposite because, where parking supply is limited, new spaces may generate new traffic.

A potentially useful strategy for the LMA would be to discontinue some of the off-site spaces in the Fenway neighborhood and replace them with an equal number of new off-site spaces near arterial streets southwest of the LMA, ideally near the junction of Routes 1 and 203 in Jamaica Plain. This would have two advantages:

(1) Many of the employees currently parking in Fenway-area facilities reside in communities southwest of the LMA and thus must drive through the LMA twice daily, contributing to LMA traffic congestion.

(2) Fenway neighborhood residents and some City agencies would prefer to see a reduction in the number of leased parking facilities in this neighborhood.

MASCO has been trying for several years to locate a suitable facility southwest of the LMA, but has met with no success to date.

D11. Coordinate a Voluntary Staggered Work Hours Program

Analysis of the 1987 MASCO survey of institutions revealed that, despite the variety of work shifts in the LMA, the 8:30 AM to 5:00 PM shift is still the rule for many LMA workers, especially administrative staff. Very few workers have shifts beginning at 8:15 AM or 8:45 AM. This concentration of arrival and departure times increases traffic delays in the area.

Staggered work hours can provide traffic reductions in the peak traffic hours, when the roadway system is most heavily taxed and delays are greatest. Traffic conditions could be somewhat improved, especially in the morning peak hour, if LMA employers offered staggered shifts or flexible work hours for administra-

tive staff. If two or more LMA employers felt that a single administrative shift was essential, it would be helpful if those employers' single administrative shifts did not coincide. MASCO could play a coordinating role in this regard. In general, later administrative work shifts would be more effective than earlier shifts, because a significant number of LMA employees already work from 7:00 AM to 3:30 PM, and traffic levels between 3:30 and 4:30 PM are almost as high as between 4:30 and 5:30 PM. Assigning administrative staff to work from 9:30 AM to 6:00 PM would be very effective in reducing traffic delays.

National studies have shown that alternative work hours can have either a positive or negative effect on ridesharing, but the net effect is usually small. When a variable work hours program is implemented, some workers who previously carpooled together may choose to drive alone at different times. On the other hand, the freedom to choose one's own shift (within defined parameters) allows carpools to form between workers at different firms which previously had incompatible schedules. In many cases, these workers at different firms are members of the same household.

In the Boston area, the benefit of shifting one's commute from the peak hour to an adjacent "shoulder" hour is more pronounced for transit commuters (especially Green Line riders) than for automobile commuters. Therefore, implementation of a staggered work hours program in the LMA is likely to result in a small net shift from automobile to public transportation.

At the U.S. Department of Transportation facility in Kendall Square, Cambridge, implementation of a flextime program in 1978 resulted in a small net decrease in the percentage of employees driving alone to work and small net gains in both the public transit and ridesharing categories. Those results, presented in

Table 6, translate to a 3.5 percent reduction in daily vehicle-trips for commuting. This reduction, if it were achieved in the LMA, would be a secondary benefit of alternative work shifts; the primary benefit would be the spreading of the peak demands on the roadway system.

TABLE 6
EFFECTS OF FLEXTIME ON MODE SPLIT

MODE	BEFORE	AFTER
Drive alone	42.5%	39.5%
Rideshare	35.4%	37.4%
Public Transit	21.5%	22.5%
Walk & Other	0.6%	0.6%
TOTAL	100.0%	100.0%

Source: M. Ott, et al., "The Behavioral Impacts of Flexible Work Hours," Transportation Systems Center, Cambridge, MA., 1980.

D12. Subsidize or Build Nearby Housing For LMA Employees

The LMA is, in some respects, a campus, but it has very little on-campus housing. On-campus housing in the LMA could lead to traffic reduction by eliminating some vehicular work trips into and out of the LMA. For example, 100 on-campus housing units occupied by workers who would otherwise drive alone to the LMA would save 200 daily vehicle trips and the demand for 100 employee parking spaces. To the extent that the units are occupied by workers who would otherwise commute by ridesharing, public transportation, or walking, the savings would be less. On-campus housing might also have other benefits, such as making the LMA a more attractive place to live and work.

There is some housing within the LMA, creating a precedent for additional units. The City has placed great emphasis on providing housing in other under-populated areas of the city, such as the Park Square area.

On the other hand, housing itself generates vehicle trips and parking demand. Studies conducted by the Institute of Transportation Engineers showed that 100 apartments generate, on average, 610 daily vehicle trips and a demand for 121 parking spaces. For housing located in the LMA and occupied by LMA workers, these figures would be lower due to the elimination of two daily work trips and the availability of public transportation. Still, it appears that constructing on-campus housing would not reduce parking demand and would probably increase daily vehicle-trip generation (though not to the same degree as other types of development).

Some traffic benefits might result from constructing on-campus housing because the majority of the new daily vehicle trips generated would occur outside the peak travel hours, while the majority of the vehicle-trips eliminated occurred during peak travel hours. This benefit would be reduced to the extent that the housing is occupied by medical interns and other LMA workers whose shifts begin and end outside the peak travel hours.

Conclusion: Level-of-Service Analysis

It is impossible to state with precision the impacts of any of the traffic reduction strategies on peak-hour traffic level-of-service at LMA intersections, because the number of vehicle-trips eliminated cannot be reliably estimated even in aggregate, much less on a particular intersection approach. Since these strategies would affect only LMA trips (not through traffic), their effect will be strongest at the Longwood Avenue/Brookline

Avenue intersection (in the center of the LMA). The potential PM peak hour impacts of traffic reduction measures are illustrated here under the very optimistic assumption that they would reduce the LMA's total (work plus non-work) PM peak hour vehicle trip generation by 10 percent compared with the 1992 traffic volumes forecast in the five-year growth horizon report.

Table 7 compares PM peak hour level of service at the Longwood Avenue/Brookline Avenue intersection under three different conditions: existing volumes, forecast 1992 volumes, and reduced 1992 volumes. In all three cases, the existing geometry and signal timing are assumed. As shown in the table, a 10 percent reduction in LMA trip generation, in the absence of other improvements, would significantly reduce delay but would not change the forecast Level-of-Service "F" in the PM peak hour at the Longwood Avenue/Brookline Avenue intersection. At other LMA intersections, where the percentage of through traffic is higher, the benefits of LMA-oriented traffic reduction measures would be even less. This means that traffic reduction measures are useful but cannot alone solve the LMA's traffic problems. Instead, they should be considered as part of a package of improvement strategies, as presented in Chapter III.

TABLE 7
POTENTIAL EFFECTS OF TRAFFIC REDUCTION

Condition	LOS	Delay	V/C
Existing Volumes	E	50	0.85
Forecast 1992 Volumes	F	102	1.05
Reduced 1992 Volumes	F	69	0.97

E. MANAGEMENT STRATEGIES

Management strategies as defined in this report are those which do not relate to a particular roadway or intersection and cannot be labeled simply as traffic reduction measures. Some management strategies relate to land use planning (including parking), and all require a strong continuing role for MASCO and the Boston Transportation Department.

Nine management strategies are evaluated:

E1. Parking management.
E2. Improve enforcement of traffic and parking regulations.
E3. Construction management.
E4. Restrain street closures.
E5. Prohibit all on-street loading between 7:00 AM and 7:00 PM.
E6. Detail traffic control officers at LMA intersections.
E7. Designate suggested ambulance routes.
E8. Designate restrictive truck routes.
E9. Assessments for LMA transportation improvements.

E1. Parking Management

Parking management strategies have potential to reduce traffic congestion throughout the LMA. Previous studies have identified the need to develop employee parking at the periphery of the LMA, to use price differentials as a way to encourage employees to elect peripheral parking, and to minimize employee trips through the LMA by assigning workers to specific off-site lots on the same side of the LMA as their residence.

These goals would be easier to achieve if parking were managed centrally by MASCO rather than by individual institutions. Currently, there are pairs of employees who would shorten their total commuting time by exchanging parking spaces, thus benefitting themselves and other users of the roadway system. A Children's Hospital employee who lives in West Roxbury and parks at Alumnae Hall and a Brigham and Women's Hospital employee who lives in Malden and parks in the Mission Park Garage would be one example of such a pair.

Also, intense competition between LMA institutions for qualified employees makes it difficult for any one institution to make parking policy changes which are unpalatable to its employees. A single parking policy, promulgated by MASCO in consultation with the institutions, might be seen by employees as a rational, even if unpleasant, solution to a difficult problem, rather than a simple cut in compensation.

With the balkanized parking management system currently in effect in the LMA, it is difficult to maintain up-to-date information on parking supply and utilization. While total parking supply and demand appear to be in balance, some facilities are underutilized while others are overcrowded. A parking manager in

control of all facilities would have the information needed to bring about desired utilization levels by lowering prices or expanding eligibility at undersubscribed facilities, while raising prices or restricting access at overtaxed facilities.

Another advantage of central control over parking policy is that MASCO would be in a better position to assess the demand for short-term and all-day parking spaces, both in general and at specific locations inside and outside the LMA. With refined demand estimates and control of parking policies, a parking manager could be more certain about which parking leases or purchases were economically rational.

With central control of parking, MASCO could implement and fund effective ridesharing incentives, help assure an adequate supply of convenient parking for patients, and develop a database for use in supply and demand forecasting.

E2. Improve Enforcement of Traffic and Parking Regulations

Enforcement of existing traffic and parking regulations is critical to the success of many of the strategies analyzed in this report. The full benefits of parking restrictions will not be realized if those restrictions are not vigorously enforced. Left-turn prohibitions, too, require enforcement. Decreased employee parking subsidies would be an ineffective traffic reduction strategy if employees found that, due to the inadequacy of enforcement, illegal on-street parking spaces cost less per month than legitimate employee parking spaces.

To keep LMA arterials clear of illegally parked vehicles, the hours of 7:00 and 9:30 AM and 2:30 to 6:30 PM appear to be the most critical enforcement periods, based on the time-of-day distribution of traffic volumes. Morning towing operations would ideally begin at 6:30 AM in preparation for the AM peak period.

To keep resident permit parking spaces available for their intended purpose, 24-hour enforcement would be beneficial, but the most important time period appears to be from 2:00 to 8:00 PM. Intensive enforcement during this period, when the majority of residents arrive at home and look for parking, would deter illegal parking by LMA employees on the three most common work shifts (8:30 AM to 5:00 PM, 7:00 AM to 3:30 PM, and 3:00 PM to 11:30 PM), as well as deterring the many hospital visitors who arrive during patient visiting hours. Daily enforcement of resident sticker parking would be desirable also for at least one hour between 11:00 PM and 7:30 AM, to assure that third-shift workers do not park in resident spaces.

LMA institutions could enhance the effectiveness of the Boston Transportation Department's resident permit parking enforcement program by informing employees, students, patients and visitors of the intensity of enforcement, severity of fines, and location of legal parking spaces. For employees and students, this information could be included in orientation materials. For the families of patients who are admitted on a planned (as opposed to emergency) basis, the information could be sent to the patient's home in advance of admission. For those who were not reached by these methods, large signs in entrance lobbies might be somewhat effective.

E3. Construction Management

Construction projects, such as roadway and utility work as well as the construction of buildings and parking garages, can have severe impacts on traffic flow. Careful management of construction projects has significant potential to mitigate these impacts. Some elements of construction management are:

- Off-street parking for construction workers,
- Off-street areas for construction staging,
- Measures to promote pedestrian safety,
- Striping and signage to reallocate remaining lanes when construction activities must take place in the street,
- Signage to indicate alternate routes when roadway capacity must be reduced, and
- Coordination of projects to assure that capacity is not reduced simultaneously on parallel roadways.

The Boston Transportation Department (BTD) recently instituted a requirement that a construction management agreement be negotiated and signed before a building permit is issued. In negotiating these agreements, the BTD is insisting that traffic not be needlessly delayed by construction projects. As a result of these new procedures, construction-related traffic disruptions in the LMA will likely be reduced.

E4. Restrain Street Closures

The transportation study commissioned by MASCO in 1975 recommended the construction of several local access roadways in the LMA to relieve pressure on arterial intersections. Despite this recommendation, the opposite trend has occurred - closure of several local access roadways has been requested by LMA institutions and approved by the City of Boston.

Although minor roadways carry very little traffic, their role in relieving congestion at arterial intersections is often underestimated. When a minor street is closed, the traffic diverted to arterial streets is comprised of a disproportionately high percentage of turning vehicles. At a busy arterial intersection, just a few additional left-turning vehicles in the peak hour can make the difference between acceptable and deficient conditions. Moreover, even if a few additional left-turns would have no impact today, they may make or break the performance of the intersection in a future year when the traffic volumes are increased.

Since private land is very rarely taken to expand roadway capacity, converting a public street to a private use is essentially irreversible. The Boston Transportation Department and MASCO, therefore, should not support any further conversions without conducting an extensive and impartial analysis of long-term traffic growth.

E5. Prohibit All On-Street Loading Between 7:00 AM and 7:00 PM

This strategy wold improve traffic flow but would have adverse impacts on retail establishments in the LMA, some of which depend on on-street deliveries due to the lack of off-street loading facilities in their buildings. A more realistic

alternative would be for LMA institutions to negotiate an agreement with each other to eliminate loading on arterials between 7:00 and 9:30 AM and between 2:30 and 6:30 PM at institutionally owned buildings.

The Boston Redevelopment Authority (BRA) and the Boston Transportation Department (BTD) now require that off-street loading facilities be included in all new or renovated buildings, unless the BTD agrees that it is infeasible in a particular case. In the LMA, the BRA and BTD should require that an off-street loading facility in a new or renovated building be designed to serve nearby existing buildings as well. In the long run, this policy should improve traffic flow in the LMA.

E6. Detail Traffic Control Officers at LMA Intersections

When the traffic volume at an intersection approach exceeds its capacity, the queues may stretch back and block other intersections. In extreme cases, this can lead to gridlock, immobilizing traffic in a large area. One way to avoid gridlock is to increase capacity or reduce traffic to relieve congestion on the intersection approach which causes the queues. When that is impossible, traffic control officers can be deployed at key intersections to ensure that standing queues do not block traffic that would otherwise be free to move. This strategy is fairly effective but very costly because it is so labor intensive. It should be considered a temporary measure or a solution of last resort. Sometimes the strategy backfires because too many drivers stop in the middle of the intersection to ask the traffic officer for directions.

An example of a potential application of this strategy in the LMA is the point where northbound Riverway traffic merges with eastbound traffic from Park Drive. During peak hours, especially in the morning, eastbound queues from the Fenway/Brookline Avenue signal sometimes block the merge area. Although a signal would be beneficial at this location, a traffic control officer might be considered as a temporary measure. Because the Riverway is owned by the Metropolitan District Commission (MDC), the control officer would have to be an MDC police officer. An MDC police officer is already stationed at the Riverway/Brookline Avenue intersection during the morning rush hour, and this strategy could be implemented as a temporary measure at the Riverway/ Longwood Avenue intersection as well.

Civilian traffic control officers employed by the Boston Transportation Department (BTD) are stationed at congested downtown intersections such as Dewey Square. The BTD could expand this program to include the Brookline Avenue/Longwood Avenue intersection in the LMA.

E7. Designate Suggested Ambulance Routes

MASCO, in consultation with the Boston Transportation Department, could designate suggested ambulance routes to the various emergency rooms in the LMA. However, it appears that ambulance drivers have no difficulty finding the fastest routes to their destinations, and no need for designated ambulance routes is apparent.

E8. Designate Restrictive Truck Routes

Truck traffic is already confined to a small set of roadways in the LMA because trucks are barred from the Riverway, the Fenway and most of Park Drive. The Boston Transportation Depart-

ment is authorized to regulate truck movements on the remaining LMA streets. However, traffic counts on the remaining LMA roadways show that trucks do not represent an especially high percentage of peak period traffic. Since truck traffic does not contribute significantly to traffic congestion in the LMA, further truck restrictions do not appear to be warranted.

E9. Assessments For LMA Transportation Improvements

Institutional assessments offer a means to finance LMA transportation improvements for which public funds are unavailable. In recent years, LMA institutions have funded signal improvements on Brookline Avenue and the widening of Longwood Avenue. In the future, assessments could potentially support other roadway and signal projects, MBTA service improvements, and carpooling programs.

F. PEDESTRIAN ACCESS IMPROVEMENTS

Five pedestrian access improvements are evaluated in this section:

F1. Install stop sign at Avenue Louis Pasteur and Longwood Avenue.
F2. Provide security to MBTA users.
F3. Improve streetscape amenities.
F4. Improve connection to Longwood Station.
F5. Build a pedestrian bridge over the Riverway.

F1. Install Stop Sign at Avenue Louis Pasteur and Longwood Avenue

This proposal, to provide stop sign control on the uncontrolled southbound approach to the intersection of Longwood Avenue and Avenue Louis Pasteur, would improve safety for

pedestrians and motorists. The cost is trivial, and no significant air quality impacts are likely to result.

F2. Provide Security to MBTA Users

Due to the LMA's urban setting, many workers feel uneasy about walking alone between their place of employment and their transit stop, especially after dark. The perception of security may be more important than the actual crime rate. It has been suggested that security personnel be stationed at MBTA stops (including bus stops). A more cost effective variant of this proposal would be for each institution's security force to incorporate a section of public sidewalk in its regular rounds. MASCO could help coordinate the institutional efforts with the Medical Area Security Patrol, a division of MASCO, which provides evening and weekend security services in the LMA. If every sidewalk in the LMA were patrolled occasionally by a uniformed guard with a two-way radio, the perception of security would be improved. This strategy, together with the one discussed in item F4, would improve the perception of security for MBTA riders and other pedestrians.

F3. Improve Streetscape Amenities

In recent years, LMA institutions and MASCO have taken increased responsibility for sidewalk amenities in the LMA. Benches and custom designed bus stops have been installed, and landscaping has been enhanced. Improved street signs have been erected, and maps at LMA Garages help customers to find their destinations. Definite benefits would accrue from expansion of this program to include high quality shelters at all MBTA and MASCO bus stops in the LMA and spacious, comfortable waiting facilities at stations on the MBTA Riverside and Arborway Lines.

One amenity found in downtown Boston that would be useful in the LMA is an orientation map display aimed at persons who arrive in the LMA via public transportation or on foot. These displays could be erected at bus and streetcar stops, at LMA entry points, and at busy sidewalk intersections within the LMA.

F4. Improve Connection to Longwood Station

Currently, the most direct route from Longwood Station to the Winsor School, Wheelock College and Beth Israel Hospital cuts through a park which is perceived to be unsafe because it is in disrepair and unlighted. After leaving the park, the pedestrian must cross the Riverway at a sharp curve without a pedestrian signal. The Boston Parks Department, the Brookline Conservation Commission, and the Massachusetts Department of Environmental Management have secured substantial state funding to upgrade the park, but the plans are not fully developed.

To improve this route and thereby improve transit access for several LMA institutions and Riverway residents, the walks and bridges in the park need to be repaired, and lighting needs to be installed. A pedestrian actuated signal at the existing Riverway crosswalk should be considered. The high traffic volumes and the presence of a school at the east end of the crosswalk justify a signal. A signal could be safely installed because northbound traffic already has a sight distance of 500 feet, which is adequate for a signal on this roadway, and a mast arm of the type used at the Riverway/Longwood Avenue intersection would provide adequate sight distance for southbound traffic. In the absence of a signal, the risk of an accident involving an eastbound pedestrian and a southbound vehicle is excessive due to poor sight distance.

The other pedestrian route between the LMA and Longwood Station also needs improvement. Unnecessary obstructions should be removed from the east sidewalk on Chapel Street, and vegetation in the adjacent park should be cut back to improve visibility and the perception of security.

F5. Build A Pedestrian Bridge Over The Riverway

A pedestrian bridge over the Riverway could improve safety for both vehicles and pedestrians. Possible locations for pedestrian bridges are the Riverway/Brookline Avenue intersection, the Riverway/Longwood Avenue intersection, and the Riverway/Short Street intersection. At Longwood Avenue, a pedestrian bridge would alleviate traffic congestion because the exclusive pedestrian phase could be eliminated.

The main drawback of pedestrian bridges is that they inconvenience pedestrians. Where a signal with walk phase is a feasible alternative, a pedestrian bridge is not really a pedestrian access improvement; it is a roadway improvement made to the detriment of pedestrians.

A related problem is that pedestrians who don't like pedestrian bridges may not use them. As a result, the traffic flow benefits and safety benefits may not materialize. In the Boston area, the only well utilized pedestrian bridges cross limited access highways, where crossing at grade is prevented by a physical barrier between opposing lanes on the roadway. The Riverway does not have a median barrier, and constructing such a barrier to force pedestrians to use bridges does not appear to be a good use of land or money.

Instead, implementation of the Riverway/Brookline Avenue one-way pair (Item C1) would enable pedestrians to cross the Riverway without any conflicting traffic at the Riverway/Brookline Avenue west crosswalk and the Riverway/Longwood Avenue north crosswalk.

G. SITE DESIGN CONSIDERATIONS

G1. Keep Garage Queues and Drop-Off Driveway Queues Off Streets

Parking garages should be designed so that the checkpoint where entering vehicles must stop to pay or take a ticket is sufficiently removed from the street so that if a queue of vehicles accumulates, it will not extend into the street and delay traffic. When this problem occurs at an existing garage, the checkpoint can be moved at relatively low cost. A few parking spaces are lost as a result of moving the checkpoint. When "Garage Full" signs are needed, these should be placed so that drivers see them before beginning to turn into the garage.

Similarly, the design of drop-off driveways affects traffic flow on the street. First, the driveway must have adequate capacity to process the vehicles using it, and second, there must be sufficient length from the entrance curb cut to the desired drop-off point so that if a queue of vehicles accumulates, it will not extend into the street and delay traffic. Since existing driveways cannot easily be modified, extra generous allowances should be made in the design. If a problem nevertheless develops, it can be mitigated by means of an attendant to assist with drop-offs and pick-ups, and, if necessary, by imposing a left-turn ban into the driveway to keep all queued vehicles on one side of the street.

Recommendations

III. RECOMMENDATIONS

The recommended plan consists of 35 of the 54 analyzed improvement strategies, including four of the eight construction strategies, nine of the ten other roadway improvement strategies, three of the nine circulation changes, seven of the 11 traffic reduction strategies, seven of the nine management strategies, four of the five pedestrian access improvements, and the one site design strategy. Six strategies are suggested for the long term (two to five years), while 28 are proposed for the short term (less than two years). The complete list is presented in Table 8.

While all the recommended strategies are important, a few merit special emphasis. In the short term, the Boston Transportation Department (BTD) and the Metropolitan District Commission (MDC) should focus primarily on reallocating available roadway width and green signal time, the MBTA should extend bus Route 19 into the LMA and link available Green Line cars into longer trains, and MASCO should concentrate on diverting employee parking subsidies to transit and ridesharing incentives. In the longer term, the BTD and the MDC should turn their attention to the Riverway/Brookline Avenue one-way pair while MASCO emphasizes staggered work hours. The most immediate need appears to be the removal of parking meters on Brookline and Longwood Avenues.

Table 8 outlines rough cost estimates for capital-intensive strategies and identifies potential funding sources for all recommended improvements. Key agencies whose approval or participation is required are also identified. For improvements to public roadways and signals, the City of Boston and the Metropolitan District Commission are identified as primary funding sources. Developers are the suggested funding source for improvements closely associated with new development. The LMA

TABLE 8
RECOMMENDED IMPROVEMENTS

No.	Description	Long/ Short Term	Primary Agencies Involved*	Potential Funding Sources	Capital Cost ($000)
ROADWAY CONSTRUCTION STRATEGIES					
A1**	Modify Intersection of Fenway and Avenue Louis Pasteur	Long	MDC/BTD	MDC/City	100
A2**	Connect Parking Facilities to Avenue Louis Pasteur	Long	BSD/EC/BRA/BTD/ BIH/CH/HMS/MASCO	Developer(s)	110
A3	Widen Longwood Avenue Between Binney Street and Brookline Avenue	Long	BTD	MCA Site Developer	220
A8	Modify the Sears Rotary: Close its Eastern Loop	Short	MDC	MDC/Sears Developer	30
	Modify the Sears Rotary: Signalize the Riverway Merge	Short	MDC	MDC/Sears Developer	55
OTHER ROADWAY IMPROVEMENTS					
B1-B8	Reallocate Available Roadway Width and Green Signal Time	Short	BTD	City	110
B9	Enhance the Effectiveness of the Longwood Avenue/Riverway Signal	Short	MDC/BTB	MDC/Town of Brookline	200
CIRCULATION CHANGES					
C1**	Riverway/Brookline Avenue One-Way Pair	Long	BTD/MDC	City/MDC/Sears Developer	400***
C2	Northbound Left-Turn Restriction at Huntington and Longwood Avenues	Short	BTD	City	5
C8**	Make Pilgrim Road Two-Way From Joslin Place to Deaconess Garage	Long	BTD/NEDH	City	15
TRAFFIC REDUCTION STRATEGIES					
D1**	Raise Parking Fees for Employees	Short	MASCO	Results in Cost Savings	
D2	Provide and Market Transit Subsidies for Employees	Short	MASCO	Parking Subsidy Reductions****	
D4	Ridesharing Program	Short	MASCO/CARAVAN	Parking Subsidy Reductions/State	
D5	"Alternatives to Driving Alone to the LMA" Campaign	Short	MASCO/CARAVAN	Parking Subsidy Reductions/State	
D6	Improve MBTA Service on the Riverside and Arborway Lines	Short	MBTA	MBTA	
D7	Improve MBTA Service to Ruggles Station and Roxbury-Dorchester (Extend MBTA Bus Route 19 into the LMA)	Short	MBTA	No Cost	
D11	Coordinate a Voluntary Staggered Work Hours Program	Long	MASCO	Parking Subsidy Reductions	

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* See following page.

** These recommendations will require further study before receiving the endorsement of MASCO and its member institutions.

*** Some of this cost is to create parkland where roadway now exists.

**** Parking subsidy reductions represent institutional funds.

TABLE 8 (Continued)
RECOMMENDED IMPROVEMENTS

No.	Description	Long/ Short Term	Primary Agencies Involved*	Potential Funding Sources
MANAGEMENT STRATEGIES				
E1**	Parking Management	Short	MASCO	Parking Subsidy Reductions***
E2	Improve Enforcement of Traffic and Parking Regulations	Short	BTD/BPD	City/MDC
E3	Construction Management	Short	BTD	Developers
E4	Restrain Street Closures	Short	BTD	No Cost
E5	Limit On-Street Loading	Short	MASCO	Institutions
E6	Detail Traffic Control Officers at LMA Intersections	Short	MDC/BTD	MDC/City
E9	Assessments for LMA Transportation Improvements	Short	MASCO	Generates Funds
PEDESTRIAN ACCESS IMPROVEMENTS				
F1	Install Stop Sign at Avenue Louis Pasteur and Longwood Avenue	Short	BTD	City
F2	Provide Security to MBTA Users	Short	MASCO	MASCO/Institutions
F3	Improve Streetscape Amenities	Short	MASCO	MASCO/Institutions/City
F4	Improve Connection to Longwood Station	Short	MDC/DEM/BPRD/BCC	State Emerald Necklace Funds
SITE DESIGN CONSIDERATIONS				
G1	Keep Garage Queues and Drop-Off Driveway Queues Off Streets	Short	BTD/MASCO	Developers

* BCC - Brookline Conservation Commission
BIH - Beth Israel Hospital
BPD - Boston Police Department
BPRD - Boston Parks and Recreation Department
BRA - Boston Redevelopment Authority
BSD - Boston School Department
BTB - Brookline Transportation Board
BTD - Boston Transportation Department
CH - Children's Hospital
DEM - Mass. Department of Environmental Management
EC - Emmanuel College
HMS - Harvard Medical School
MASCO - Medical Area Service Corporation
MBTA - Mass. Bay Transportation Authority
MDC - Metropolitan District Commission
NEDH - New England Deaconess Hospital

** These recommendations will require further study before receiving the endorsement of MASCO and its member institutions.

*** Parking subsidy reductions represent institutional funds.

institutions are expected to fund traffic reduction measures such as MBTA pass subsidies and ridesharing programs. These programs are, in the long run, more expensive than the proposed roadway improvements, but they can be funded through reductions in parking subsidies. The most important funding recommendation of this study is for the LMA institutions to reduce parking subsidies and redirect those institutional funds toward (1) implementing the other recommended transportation improvement strategies, and (2) providing a variety of more cost-effective employee benefits that attract and retain qualified workers without adversely impacting the transportation system.

Conclusion

In summary, with the recommended improvements, all signalized intersections in the LMA can carry forecast volumes at acceptable levels of service. All recommended improvements are both technically and institutionally feasible. All can be implemented within five years, and most can be carried out within just two years. None require major construction, disruption, or eminent domain takings. All strategies with significant adverse effects on adjacent neighborhoods are rejected, and increased enforcement of resident permit parking is part of the recommended plan. As a result, the net impact on adjacent neighborhoods is positive due to improvements to the roadway, transit and pedestrian systems used by area residents.

The recommended plan balances the interests of the LMA's neighbors with the interests of the MASCO member institutions' employees and students, of whom 38 percent are Boston residents. Unlike the 1975 plan, which was technically sound but politically and institutionally naive, this plan does not involve taking private property and public parkland along Francis Street,

Longwood Avenue, Huntington Avenue and the Riverway, but instead makes the existing transportation system work as built. The plan presents the institutions and its neighbors with a "win-win" situation, in which the cooperation of all parties can bring about mutually beneficial solutions.

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